

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
Petitioner

v.

NINGDE AMPEREX TECHNOLOGY LIMITED,
Patent Owner

Case IPR2026-00401
U.S. Patent No. 12,294,082

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 12,294,082**

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<i>E.I. du Pont de Nemours & Co. v. Synvina C.V.</i> , 904 F.3d 996 (Fed. Cir. 2018)	10, 29, 31, 38
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EXHIBIT LIST

Exhibit No.	Description
1001	U.S. Patent No. 12,294,082 (“the ’082 Patent”)
1002	File history of U.S. Patent No. 12,294,082
1003	Declaration of Samuel Gido, Ph.D.
1004	<i>Curriculum Vitae</i> of Samuel Gido, Ph.D.
1005	U.S. Patent Application Publication No. 2018/0248220 A1 to Noriko Manabe et al. (“Manabe”)
1006	Japanese Patent Publication No. JP 2014-89855 to Inaba et al. (“Inaba”)
1007	Certified Translation of Japanese Patent Publication No. JP 2014-89855 to Inaba et al. (“Inaba”)
1008	Chinese Patent Application CN 109509909 A to Wang et al. (“Wang,” EX1008)
1009	Certified Translation of Chinese Patent Application CN 109509909 A to Wang et al. (“Wang,” EX1009)
1010	U.S. Patent Application Publication No. 2018/0316001 A1 to Kim et al. (“Kim”)
1011	U.S. Patent Application Publication No. 2014/0227562 A1 to Kamizori et al. (“Kamizori”)
1012	U.S. Patent Application Publication No. 2019/0148762 A1 to Torita et al. (“Torita”)
1013	U.S. Patent Application Publication No. 2017/0033355 A1 to Kondo et al. (“Kondo”)

Exhibit No.	Description
1014	Manuella Cerbelaud et al., <i>Numerical and Experimental Study of Suspensions Containing Carbon Blacks Used as Conductive Additives in Composite Electrodes for Lithium Batteries</i> . LANGMUIR, Feb. 24, 2014, at 2660–2669.
1015	Sigma-Aldrich Super P product details, downloaded on June 22, 2026, from https://www.sigmaaldrich.com/US/en/product/aldrich/940259
1016	S. Lim et al., <i>The effect of binders on the rheological properties and the microstructure formation of lithium-ion battery anode slurries</i> . JOURNAL OF POWER SOURCES, Sept. 11, 2015, at 221-230.
1017	Jieun Park et al., <i>How the interaction between styrene-butadiene-rubber (SBR) binder and a secondary fluid affects the rheology, microstructure and adhesive properties of capillary-suspension-type graphic slurries used for Li-ion battery anodes</i> . COLLOIDS AND SURFACES A, July 19, 2019, at 579.
1018	Complaint for Patent Infringement, <i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , No. 2:26-cv-00139-JRG (E.D. Tex. Feb. 18, 2026), ECF 1.
1019	Order (granting Dismissal Without Prejudice), <i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , No. 2:26-cv-00139-JRG (E.D. Tex. June 16, 2026), ECF 17.

CLAIMS APPENDIX

Claim Element	Language
Claim 1	
[1.pre]	A negative electrode, comprising:
[1.1]	a negative current collector;
[1.2]	a first negative active material layer, wherein the first negative active material layer is arranged on one side of a first portion of the negative current collector; and
[1.3]	a second negative active material layer, wherein the second negative active material layer is arranged on two sides of a second portion of the negative current collector, wherein the second portion of the negative current collector is different from the first portion of the negative current collector;
[1.4]	wherein a ratio of a weight per unit area of the first negative active material layer to a weight per unit area of the second negative active material layer on the negative current collector is 0.47 to 0.52, and
[1.5]	a ratio of a compacted density of the first negative active material layer to a compacted density of the second negative active material layer is 0.9 to 1.1;

Claim Element	Language
[1.6]	wherein a thickness of the first negative active material layer is 40 μm to 60 μm , and a thickness of the second negative active material layer on each of the two sides of the second portion is 40 μm to 60 μm .
Claim 2	
[2.1]	The negative electrode according to claim 1, the weight per unit area of the first negative active material layer on the first portion is 65 g/m^2 to 130 g/m^2 , and the weight per unit area of the second negative active material layer on the second portion is 130 g/m^2 to 260 g/m^2 .
Claim 3	
[3.1]	The negative electrode according to claim 1, wherein the first negative active material layer and the second negative active material layer each independently comprise a silicon-based material and graphite, wherein the silicon-based material is selected from the group consisting of silicon oxide, silicon carbon, and a combination thereof.
Claim 4	
[4.1]	The negative electrode according to claim 3, wherein a weight of the silicon-based material in the first negative active material layer and the second negative active material layer is greater than or equal to 5% and less than 100%, based on a total weight of the silicon-based material and the graphite.

Claim Element	Language
Claim 5	
[5.1]	The negative electrode according to claim 3, wherein a form of the silicon-based material comprises a crystalline state, an amorphous state, or a combination thereof,
[5.2]	wherein the first negative active material layer has a particle size Dv50 of 8.0 μm to 20 μm , and the second negative active material layer has a particle size Dv50 of 8.0 μm to 20 μm .
Claim 6	
[6.1]	The negative electrode according to claim 3, wherein for the silicon-based material, a ratio of a peak height at a wavenumber of $500\text{ cm}^{-1} \pm 10\text{ cm}^{-1}$ to a peak height at a wavenumber of $1350\text{ cm}^{-1} \pm 10\text{ cm}^{-1}$ in a Raman spectrum is greater than 0.
Claim 7	
[7.1]	The negative electrode according to claim 3, wherein the silicon-based material further comprises a carbon coating layer.
Claim 8	
[8.1]	The negative electrode according to claim 3, wherein the first negative active material layer and the second negative active material layer each independently comprise a binder and a conductive agent;

Claim Element	Language
[8.2]	wherein the binder comprises a material selected from the group consisting of polyacrylate, polyimide, polyamide, polyamideimide, polyvinylidene fluoride, styrene-butadiene rubber, sodium alginate, polyvinyl alcohol, polytetrafluoroethylene, polyacrylonitrile, sodium carboxymethyl cellulose, potassium carboxymethyl cellulose, and a combination thereof; and
[8.3]	the conductive agent comprises a material selected from the group consisting of conductive carbon black, acetylene black, Ketjen black, graphene, and a combination thereof.
Claim 9	
[9.1]	The negative electrode according to claim 8, wherein based on a total weight of the first negative active material layer, the total weight of the silicon-based material and the graphite in the first negative active material layer is 94% to 96%, a weight of the binder is 2.8% to 5.0%, and a weight of the conductive agent is 0.4% to 1.6%; and based on a total weight of the second negative active material layer, the total weight of the silicon-based material and the graphite in the second negative active material layer is 94% to 96%, the weight of the binder is 2.8% to 4.0%, and the weight of the conductive agent is 0.4% to 1.6%.
Claim 10	
[10.pre]	An electrochemical apparatus, comprising:

Claim Element	Language
[10.1]	a positive electrode;
[10.2]	a separator; and
[10.3]	a negative electrode; wherein the negative electrode comprises
[10.4]	a negative current collector;
[10.5]	a first negative active material layer, wherein the first negative active material layer is arranged on one side of a first portion of the negative current collector; and
[10.6]	a second negative active material layer, wherein the second negative active material layers are arranged on two sides of a second portion of the negative current collector, wherein the second portion of the negative current collector is different from the first portion of the negative current collector,
[10.7]	wherein a ratio of a weight per unit area of the first negative active material layer to a weight per unit area of the second negative active material layer on the negative current collector is 0.47 to 0.52, and
[10.8]	a ratio of a compacted density of the first negative active material layer to a compacted density of the second negative active material layer is 0.9 to 1.1;

Claim Element	Language
[10.9]	wherein a thickness of the first negative active material layer is 40 μm to 60 μm , and a thickness of the second negative active material layer on each of the two sides of the second portion is 40 μm to 60 μm .
Claim 11	
[11.1]	An electronic apparatus, comprising the electrochemical apparatus according to claim 10.
Claim 12	
[12.1]	The electrochemical apparatus according to claim 10, the weight per unit area of the first negative active material layer on the first portion is 65 g/m^2 to 130 g/m^2 , and the weight per unit area of the second negative active material layer on the second portion is 130 g/m^2 to 260 g/m^2 .

I. INTRODUCTION

Zhuhai CosMX Battery Co., Ltd (“Petitioner”) requests *inter partes* review to cancel claims 1-12 (“the challenged claims”) of U.S. Patent No. 12,294,082 (“the ’082 Patent,” EX1001), assigned to Ningde Amperex Technology Limited (“Patent Owner” or “PO”). This Petition is supported by the declaration of Dr. Samuel Gido (EX1003), an expert in the field of materials science and engineering, including battery applications.

The challenged claims recite a negative electrode with first and second negative active material layers (“NAML”) arranged on a current collector. The first NAML is on one side of the current collector, and the second NAML is on both sides of a separate portion of the current collector. The ratio of the weight per unit area of the first NAML to second NAML is 0.47-0.52. The ratio of the compaction densities of the first NAML to second NAML is 0.9-1.1. The first and second NAMLs have thicknesses between 40-60 μ m on each of the two sides of the current collector.

Each limitation is present in the prior art. Manabe (EX1005, Ground 1) discloses a negative electrode with first and second NAMLs, where the first NAML is on one side of the current collector and the second NAML is on both sides of a separate portion of the current collector. Manabe further discloses that the ratio of weight/area of the first to second NAML is 0.5 and the ratio of compaction densities is 1.0. *Titanium Metals Corp. v. Banner*, 778 F.2d 775, 782-783 (Fed. Cir. 1985)

(claimed range met by prior art teaching points within the claimed range). Manabe also discloses the first and second NAMLs have a thickness of 40-120 μ m on each of the two sides of the current collector. *In re Peterson*, 315 F.3d 1325, 1329 (Fed. Cir. 2003) (“even a slight overlap in range establishes a *prima facie* case of obviousness.”).

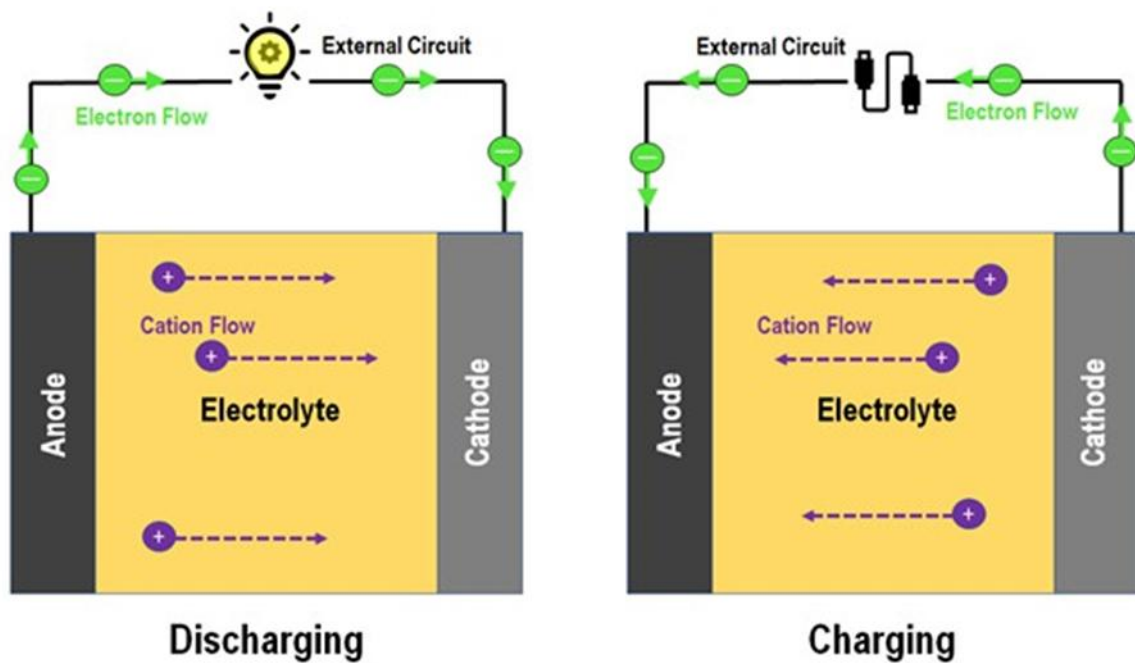
Accordingly, for the reasons below, Petitioner requests institution of IPR and cancellation of the challenged claims.

II. TECHNOLOGY BACKGROUND

A. LITHIUM-ION BATTERY TECHNOLOGY

The structure of a battery is illustrated below:

General Battery Schematic



EX1003, ¶35.

A battery includes a negative electrode (anode) and a positive electrode (cathode). EX1003, ¶36. The electrodes are separated from one another and immersed in an electrolyte through which ions are transported. *Id.*

When the battery discharges, positive ions diffuse from the anode, through the electrolyte, to the cathode. EX1003, ¶37. Electrons move separately through an external circuit from the anode to the cathode, combining with the ions at the cathode. The electrons generate an electrical current when moving through the external circuit. *Id.*

Charging the battery involves the reverse process. EX1003, ¶38. An external voltage pushes electrons through the external circuit to the anode, creating positive ions at the cathode. The positive ions migrate through the electrolyte and combine with the electrons at the anode. *Id.*

One type of battery is a lithium-ion battery. EX1003, ¶39. In lithium-ion batteries, the ions moving between the anode and cathode are lithium ions. *Id.*

B. ANODE TECHNOLOGY

As explained, the anode of a lithium-ion battery releases lithium ions during discharge, causing electrons to flow out of the anode into the device powered by the battery. EX1003, ¶40. A typical anode is comprised of a current collector coated with active material(s). *Id.* The current collector provides an electrical pathway between the active material and the external circuit (i.e., device powered by the

battery), while the active material stores and releases lithium ions during charging and discharging. *Id.* Current collectors are typically metal foil, such as copper. *Id.* Anode active materials commonly include graphite and/or silicon-based materials (e.g., silicon and silicon oxides). *Id.*

The typical process for manufacturing anodes comprises coating the active material—often in a slurry or mixture with other materials, including binding agents¹ and conductive agents²—on the current collector at a specified weight per unit area (i.e., coating weight). EX1003, ¶41. The anode is then calendared through a rolling press, compacting the active material and bonding the active material to the current

¹ Common binding agents include “fluororesins such as polytetrafluoroethylene (PTFE), polyvinylidene fluoride (PVDF) and vinylidene fluoride (VDF)-hexafluoropropylene (HFP) copolymer; polyolefin resins such as polyethylene and polypropylene; polyamide resins such as aramid;” cellulose binders such as CMC, “and rubbery materials such as styrene-butadiene rubber and acrylic rubber.” EX1005, ¶¶[0044]; EX1003, ¶41 n.1.

² Common conductive agents include carbon blacks such as acetylene black; conductive fibers such as carbon nanotubes and other forms of conductive carbon. EX1003, ¶41 n.2; EX1005, ¶[0042].

collector. *Id.* Compaction of the active material improves volumetric energy density and electrical conductivity. *Id.*

Finally, it was well known to leave a portion of the current collector uncoated by active material. EX1003, ¶42. The uncoated portion of the current collector is welded or bonded to the terminal of the battery—typically through a tab—forming an electrical connection allowing the flow of electrons into and out of the anode. *Id.* It was further well known only one side of one portion of the current collector should be left uncoated, preferably coating the rest of the current collector with active material on both sides to maximize the amount of active material and therefore battery capacity. EX1003, 42.

III. STATEMENT OF PRECISE RELIEF REQUESTED

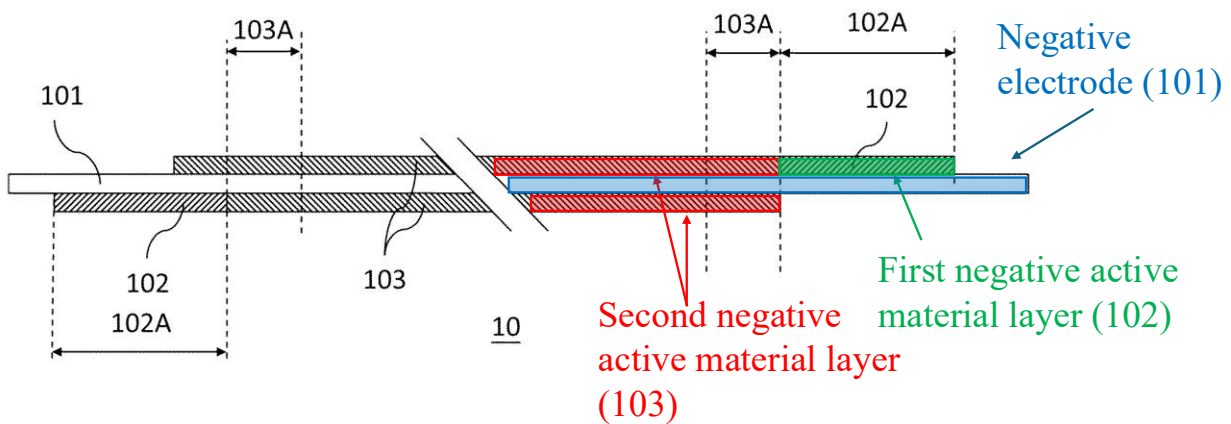
Petitioner requests *inter partes review*, seeking cancellation of claims 1-12 of the '082 Patent as having been obvious.

IV. THE '082 PATENT

The '082 Patent issued on May 6, 2025, from U.S. Patent Application No. 17/707,129 (“the '129 Application”) filed March 29, 2022. This is a continuation of PCT/CN2019/130465 filed December 31, 2019. EX1001, 1. The '082 Patent claims priority to China Patent Application No. 201911267132.X filed December 11, 2019.

A. SPECIFICATION AND CLAIMS

The '082 Patent describes a negative electrode comprising a negative current collector, a first NAML on one side of a first portion of the current collector, and a second NAML on both sides of a second portion of the current collector. EX1001, Abstract, 4:9-16.



EX1001, Fig. 1*³

The weight per unit area (i.e., coating weight) of the first NAML and second NAML—including the active material on both sides of the current collector—is such that the ratio of first to second NAML coating weights is 0.47-0.52. *Id.*, Abstract, 4:17-21. The ratio of compaction densities of the first to second NAMLs is 0.9-1.1. *Id.*, Abstract, 4:21-24. The thickness of both the first and second NAMLs—for each

³ Petitioner uses an asterisk “*” to indicate annotated or modified figures from the references.

side individually of the second NAML—is 40-60 μ m. *Id.*, Abstract, 5:55-58. In practice, the conditions mean the first NAML is, to within fairly narrow tolerances, the same as a single layer of the second NAML in terms of coating weight and compaction density. EX1003, ¶45.

According to the '082 Patent, when NAMLs obey the above restrictions—specifically, the restrictions on relative compaction densities and coating weights—polarization and lithium plating issues are alleviated, improving “cycle performance and the safety of the lithium-ion battery.” EX1001, 3:66-4:6; 15:10-17.

The independent claims recite the above negative electrode having the above-described NAML characteristics. EX1001, claims 1, 10. The '082 Patent also claims other parameters, such as specific materials in the NAMLs and their characteristics. *Id.*, claims 3-9, 11-12, 5:23-8:44.

B. PROSECUTION HISTORY

1. The '129 Application

The Examiner issued the '082 Patent despite prior art disclosing the claimed elements, solely due to purported unexpected results of the combination of ratio of coating weights and ratio of compaction densities. Had the Examiner been aware of the prior art presented in this Petition, the '082 Patent would not have issued.

The '129 Application was initially rejected based on Morimoto alone and in combination with other references. EX1002, 362-371; *see also*, 334-359. The

Examiner found Morimoto discloses a negative electrode comprising a negative current collector with a first NAML on one side of a first portion of the current collector and a second NAML on two sides of a second, different portion of the current collector. *Id.*, 363. The Examiner found Morimoto's first and second NAMLs are made of the same material, therefore the coating weights are proportional to the thickness of the layers. *Id.* With thicknesses of 67 μ m and 133 μ m, the corresponding ratio of coating weights is 0.503. *Id.* Because the first NAML is 0.503 times both the thickness and coating weight of the second NAML, the compaction density ratio is 1. *Id.*

The Examiner found Torita (EX1012) discloses using silicon oxide and graphite as negative electrode active materials and it would have been obvious to combine with Morimoto. EX1002, 364. The Examiner found Torita teaches silicon oxide should be 2-10% of the total mass of silicon oxide plus graphite and NAML thicknesses of 50-250 μ m, overlapping the claimed range. *Id.*, 365-366. The Examiner found Torita further teaches silicon oxide with a Dv50 between 1-20 μ m. *Id.*, 366-367.

The Examiner found Kim (EX1010) teaches silicon oxide in NAMLs can be in crystalline or amorphous form. EX1002, 367.

The Examiner found Kamizori (EX1011) teaches coating silicon oxide with a carbon coating layer and peaks in the Raman spectrum at 510 cm^{-1} and 1343 cm^{-1} greater than 0, thus their ratio is necessarily greater than 0. EX1002, 368.

The Examiner found Morimoto and Torita teach binders, including styrene-butadiene rubber. EX1002, 369. Torita teaches using carbon black or acetylene black as conductive agents and specific mass ratios for all the components of the NAML. *Id.*, 369-370. Kondo (EX1013) teaches these conductive agents increase the conductivity of an electrode. *Id.*, 369.

Finally, though Morimoto does not provide an embodiment where Morimoto's battery is used in an electronic device, the Examiner found it would have been obvious to do so. EX1002, 370-371.

In response, PO amended the independent claims to add the NAML thickness requirement and make clear the second portion is a second portion of the negative current collector. EX1002, 375. Without disputing the disclosed subject matter of Examiner's cited references, PO argued Morimoto and Torita cannot be combined to teach the independent claims because the Examiner relied on the thicknesses from Morimoto to meet the claimed ratios of coating weights and compaction densities, but combining with Torita would alter those thicknesses. *Id.*, 384. Further, PO argued there was no motivation to alter Torita's layers to Morimoto's configuration, especially as Morimoto's thicknesses already fell within Torita's range. *Id.*, 384-

386. PO finally argued the claimed coating weight ratio had unexpected results. *Id.*, 386-387.

The Examiner did not consider PO's arguments but, instead, found the claims allowable because of unexpected results of not just the ratio of coating weights, but the combination of ratio of coating weights and ratio of compaction densities. EX1002, 423-424.

2. Prior Art Never Considered by Examiner

None of the references relied upon in the Grounds below were before the Examiner during prosecution of the '129 Application. Petitioner's prior art teaches the combination of ratios of coating weights and compaction densities falling within the claimed range, not just overlapping values, rendering the "unexpected results" argument moot.⁴ Specifically, Manabe (EX1005) teaches a negative electrode with

⁴ The Examiner erred in allowing the '082 Patent to issue based on unexpected results. The Examiner cited Morimoto as disclosing a compaction density ratio of 1.0 and a coating weight ratio of 0.503. EX1002, 363. These values are within the claimed ranges, and therefore the doctrine of criticality or unexpected results is inapplicable. *E.I. du Pont de Nemours & Co. v. Synvina C.V.*, 904 F.3d 996, 1006 (Fed. Cir. 2018); *Titanium Metals*, 778 F.2d at 782-83. It is immaterial that the prior art did "not teach or suggest" the relationship of the claimed ratios and improved

first and second NAMLs with a coating weight ratio of 0.50 and compaction density ratio of 1.0, values directly in the middle of the claimed ranges of the key factors contributing to the purported unexpected results. *See* Section VIII.B.

Manabe (EX1005): In addition to disclosing the claimed ratios of coating weights and compaction densities, Manabe discloses a negative electrode with the claimed configuration: a first NAML on one side of a first portion and a second NAML on both sides of a second portion. *See* Section VIII.B.3-4. Manabe further discloses thicknesses for the active material layers overlapping the claimed range. *See* Section VIII.B.7. Thus, Manabe renders obvious the independent claims of the '082 Patent.

capacity retention. *See* EX1002, 424; *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 419 (2007) (“In determining whether the subject matter of a patent claim is obvious, neither the particular motivation nor the avowed purpose of the patentee controls.”); *Cross Med. Prods., Inc. v. Medtronic Sofamor Danek, Inc.*, 424 F.3d 1293, 1323 (Fed. Cir. 2005) (“[A POSITA] need not see the identical problem addressed in a prior art reference to be motivated to apply its teachings.”). Petitioner reserves the right to further address this issue, if necessary, and any other issues Patent Owner may raise related to 35 U.S.C. § 325(d) or discretionary denial.

Manabe's description of specific materials included in its NAMLs and their proportions renders obvious multiple dependent claims.

Inaba (EX1007): Inaba discloses a NAML composition of silicon-oxide coated by carbon, and graphite. *See* Section IX.A. The Dv50 of Inaba's NAML particles falls within the claimed range. *See* Section IX.B.2. Inaba coats the silicon-oxide material with carbon such that the ratio of the peak height in Raman Spectroscopy at 510 cm^{-1} to the peak height at 1343 cm^{-1} is 0.25 or less, within the claimed range. *See* Section IX.C.

Wang (EX1009): Wang discloses a NAML composition of silicon monoxide and graphite. *See* Section X.A. The Dv50 of Wang's NAML particles falls within the claim range. *See* Section X.B.2.

V. PERSON OF ORDINARY SKILL IN THE ART

A person of ordinary skill in the art ("POSITA") at the time of the alleged invention in 2019 would have had at least a bachelor's degree in chemistry, chemical engineering, materials science, or a related field covering relevant principles of organic and inorganic chemistry, polymer processing, ceramic materials, and ceramic processing, and three or more years of experience related to electrochemical energy storage devices, lithium-ion battery technology, separators, characterizations and analyses of particle size, film thickness, and/or materials compositions, battery performance characterization, or other similar applications of polymer chemistry,

ceramic chemistry, and ceramic processing. *See* EX1003, ¶¶23-24. This level of skill is approximate, and more experience could compensate for less formal education, and vice versa. *Id.* Petitioner’s technical expert, Dr. Gido, qualified as a POSITA by at least 2004. EX1003, ¶25.

VI. CLAIM CONSTRUCTION

In IPR, all claim terms receive their ordinary and customary meaning as understood by a POSITA at the time of the invention, in light of the specification and prosecution history. *See* 37 C.F.R. § 42.100(b); 35 U.S.C. § 282(b). No claim terms require express construction for purposes of granting the Petition, and the prior art renders obvious the challenged claims under any reasonable construction.

VII. IDENTIFICATION OF CHALLENGES AND PRIOR ART

Petitioner requests IPR of the challenged claims under 35 U.S.C. § 103 as follows:

Ground	Claims	Reference(s)
1	1-4, 7-12	<ul style="list-style-type: none">• U.S. Patent Application Publication No. 2018/0248220 A1 to Noriko Manabe et al. (“Manabe,” EX1005)
2	5, 6	<ul style="list-style-type: none">• Manabe• Japanese Patent Publication No. JP 2014-89855 to Inaba et al. (“Inaba,” EX1006, EX1007)

3	5	<ul style="list-style-type: none">• Manabe• Chinese Patent Application CN 109509909 A to Wang et al. (“Wang,” EX1008, EX1009)
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Petitioner’s prior art references are U.S. or foreign patent documents that qualify as prior art under §§ 102(a)(1) and 102(a)(2) even if the ’082 Patent is entitled to its earliest claimed priority date of December 11, 2019.

A. MANABE

Manabe, a U.S. patent application, was filed February 20, 2018, and published August 30, 2018. EX1005. Manabe additionally claims priority to August 28, 2015, based on JP 2015-169790. *Id.* Thus, Manabe qualifies as prior art under §§ 102(a)(1) and 102(a)(2).

B. INABA

Inaba, a Japanese patent application, was filed October 30, 2012, and published May 15, 2014. EX1007. Thus, Inaba qualifies as prior art under §102(a)(1).

C. WANG

Wang, a Chinese patent application, was filed October 17, 2018, and published March 22, 2019. EX1009. Thus, Wang qualifies as prior art under §102(a)(1).

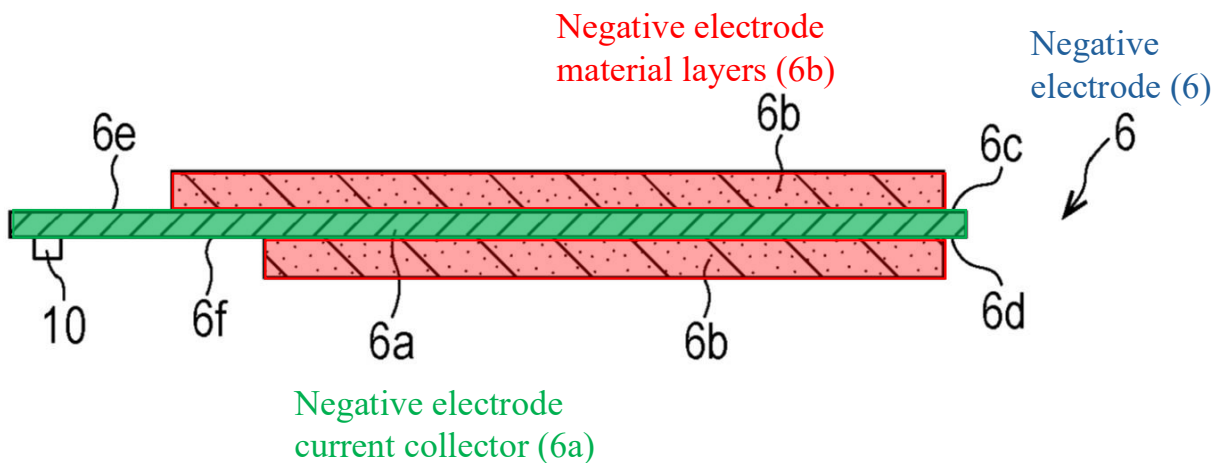
VIII. GROUND 1: MANABE RENDERS OBVIOUS CLAIMS 1-4, 7-12

A. OVERVIEW OF MANABE

Manabe discloses a nonaqueous electrolyte secondary battery with high capacity, high output, and excellent high-temperature cycle characteristics. EX1005, ¶[0012]. Example applications of Manabe's battery include: "power supplies for ... cellphones, laptop computers and smartphones,...[electric and hybrid vehicles], and storage-related power supplies." *Id.*, ¶[0126].

Manabe's battery includes a positive electrode, negative electrode, and separator. EX1005, ¶¶[0011], [0023], [0026]-[0029]. The negative electrode includes a negative electrode current collector and negative electrode mixture layer comprised of a silicon compound and a carbon material. *Id.* The silicon compound is preferably a SiO_x , where $0.5 \leq x \leq 1.5$. *Id.*, ¶¶[0017], [0020], [0052]. Manabe prefers the silicon compound is 5-30 mass% of the total mass of the carbon material and silicon compound of the negative electrode mixture layer. *Id.*, ¶¶[0017], [0021], [0053]. The silicon compound (SiO_x) in the negative electrode mixture layer expands during charging, suppressing the swelling of the positive electrode plate and consequently improving the electrical contact of the positive electrode. EX1005, ¶[0020]. This improves the performance of the positive electrode and the battery at high-temperatures. *Id.*

The following is a schematic, cross-sectional view of Manabe's negative electrode:



EX1005, Fig. 3(b)*

Manabe discloses a “negative electrode (6) including a long negative electrode current collector (6a) with negative electrode mixture layers (6b) disposed on both sides of the current collector.” EX1005, ¶[0028]. One end of the current collector is exposed equally on both sides (6c and 6d). *Id.* At the other end, one side of the current collector has a longer exposed area (6f) than the opposite side (6e). *Id.* The negative electrode lead (10) is welded to the longer exposed area of the current collector. *Id.*

Manabe discloses positive electrode structure details. *Id.*, ¶¶[0030]-[0049]. Manabe further discloses details of its separator and electrolyte. *Id.*, ¶¶[0062]-[0067].

Manabe's negative electrode includes a current collector that is either a porous or nonporous conductive substrate. EX1005, ¶[0050]. The thickness of the current collector ranges from 3-50 μ m, and most preferably 10-20 μ m. *Id.*, ¶¶[0030], [0050]. The current collector is metal, such as stainless steel, or nickel, but preferably copper or copper alloy. *Id.*, ¶[0050]. The negative electrode mixture layer includes a negative electrode active material layer, binder, and may include a conductive auxiliary and thickener. *Id.*, ¶[0051]. The negative electrode mixture is applied as a slurry to the surface of the current collector, then rolled and dried to form the negative electrode mixture layer. *Id.*

The negative electrode active material includes a carbon material and a silicon compound. EX1005, ¶[0052]. The carbon material is not limited, but Manabe provides examples: "graphites (including natural graphite, artificial graphite, and graphitized mesophase carbon), cokes, semi-graphitized carbons, graphitized carbon fibers, and amorphous carbons." *Id.* The silicon compounds are not limited, but Manabe identifies silicon oxides and silicides as examples. *Id.* Preferably, SiO_x (where $0.05 \leq x \leq 1.5$) is the silicon compound. *Id.* SiO_x is between 2-50 mass% (preferably 5-30 mass%) of the total mass of the carbon material plus the SiO_x. *Id.*, ¶[0053]. Below that range, there is insufficient SiO_x to expand and thereby improve the contact of the positive electrode, therefore the intended benefit of compressing the positive electrode and improving the electrical contact of the positive electrode

is not obtained. *Id.*, ¶[0054]. If SiO_x is above that range, the expansion and shrinkage experienced during charging and discharging is too great, causing deterioration of the cycle characteristics. *Id.* Manabe further coats the surface of SiO_x with carbon to improve the poor conductivity of SiO_x. *Id.*, ¶[0055].

The binder can be any known binding agent or combination of binding agents.

EX1005, ¶¶[0044], [0057]. Examples include:

fluororesins such as polytetrafluoroethylene (PTFE), polyvinylidene fluoride (PVDF) and vinylidene fluoride (VDF)-hexafluoropropylene (HFP) copolymer; polyolefin resins such as polyethylene and polypropylene; polyamide resins such as aramid; and rubbery materials such as styrene-butadiene rubber and acrylic rubber.

Id., ¶[0044]. The binder is no more than 10 mass% of the negative electrode active material, preferably less than 3 mass%. *Id.*, ¶¶[0045], [0057].

The conductive auxiliaries for the negative electrode mixture layer are not limited, and can include “carbon blacks such as acetylene black, conductive fibers such as carbon fibers and metal fibers, and carbon fluorides.” EX1005, ¶¶[0042], [0057]. The conductive auxiliary should be 0.5-1.5 mass% of the negative electrode mixture layer. *Id.*, ¶¶[0043], [0057]. Below that range, the discharge characteristics are significantly decreased. *Id.*, ¶[0043]. Above that range, battery capacity is decreased. *Id.*

Manabe provides examples of thickeners: “cellulose derivatives such as carboxymethylcellulose (CMC); C2-4 polyalkylene glycols such as polyethylene glycol and ethylene oxide-propylene oxide copolymer; polyvinyl alcohols; and solubilized modified rubbers.” EX1005, ¶¶[0046], [0057]. The amount of thickener is not limited but is preferably between 0.01-5 mass%. *Id.*, ¶[0047].

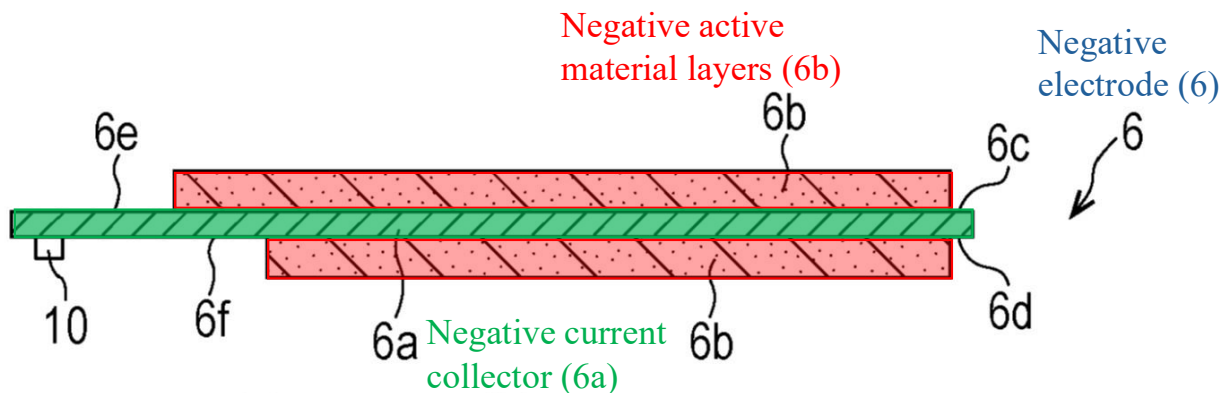
The negative electrode mixture layers are preferably 40-120μm thick per side of the current collector. EX1005, ¶[0058]. The density of the negative electrode active material is preferably 1.3-1.9g/cm³. *Id.*

Manabe’s experiments confirm the effectiveness of its battery design. EX1005, ¶¶[0070]-[0125]. Table 1 confirms the presence of SiO_x in the negative electrode contributes to improved high-temperature cycle characteristics and increased capacity retention. *Id.*, Table 1, ¶[0088]. Table 5 confirms increasing the mass% of SiO_x increases the ratio of expansion after charging, thus increasing the compression effect on the positive electrode. *Id.*, Table 5, ¶[0110].

B. INDEPENDENT CLAIM 1

1. [1.pre]: “A negative electrode, comprising:”⁵

Manabe discloses or suggests this element. EX1003, ¶¶76-77. Specifically, Manabe discloses a nonaqueous electrolyte secondary battery that includes a *negative electrode* (negative electrode 6):



EX1005, Fig. 3(b)*

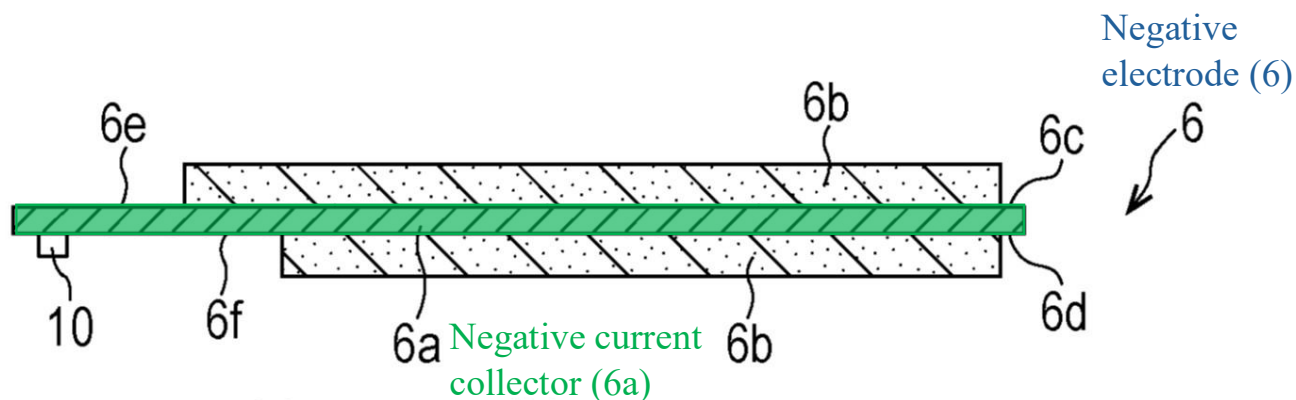
Manabe discloses “a nonaqueous electrolyte secondary battery which includes an electrode assembly that includes a...negative electrode including a negative electrode current collector and a negative electrode mixture layer.” EX1005, Abstract; *see also id.*, ¶¶[0011], [0015], [0017], [0028], [0050]-[0061]. Manabe provides negative electrode schematics. *Id.*, FIGS. 3(a)-(c), ¶[0015]. Manabe

⁵ The enclosed Claims Appendix includes the Challenged Claim language with bracketed reference numerals identifying respective Claim Elements referenced in the Petition.

describes specific compositions of the negative electrode, including active material layer components and the dimensions and/or proportions of the components of the negative electrode. *Id.*, ¶¶[0050]-[0061]. Manabe further provides multiple examples of batteries including negative electrodes. EX1005, ¶¶[0070]-[0081].

2. [1.1]: “a negative current collector”

Manabe discloses or suggests this element. EX1003, ¶¶78-79. Specifically, Manabe’s negative electrode includes a *negative current collector* (negative electrode current collector 6a):



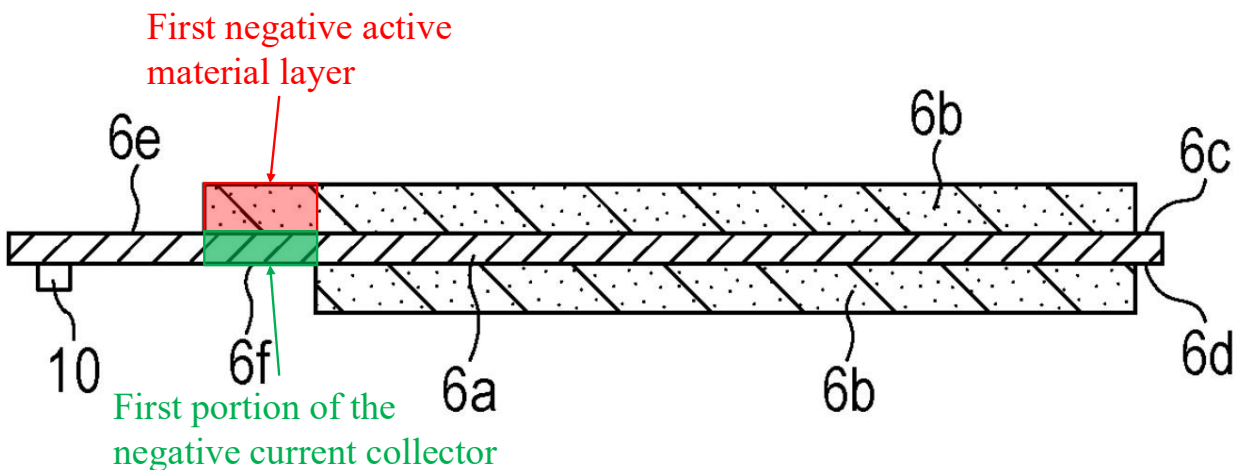
EX1005, FIG. 3(b)*

Manabe discloses “negative electrode 6 includes a long negative electrode current collector 6a, and negative electrode mixture layers 6b disposed on both sides of the negative electrode current collector 6a.” EX1005, ¶[0028]. The negative current collector is a conductive substrate with a thickness of 3 to 50μm. *Id.*, ¶¶[0030], [0050]. The negative current collector is made of metal, including copper

or copper alloys. *Id.*, ¶[0050]. Similarly, the '082 Patent's negative current collector is copper. EX1001, 6:61-62.

3. [1.2]: “a first negative active material layer, wherein the first negative active material layer is arranged on one side of a first portion of the negative current collector; and”

Manabe discloses or suggests this element. EX1003, ¶¶80-81. Specifically, Manabe's negative electrode has a *first negative active material layer* (negative electrode mixture layer 6b) *arranged on one side* (top side only) *of a first portion* (highlighted single-sided-coated portion) *of the negative current collector* (negative electrode current collector 6a):



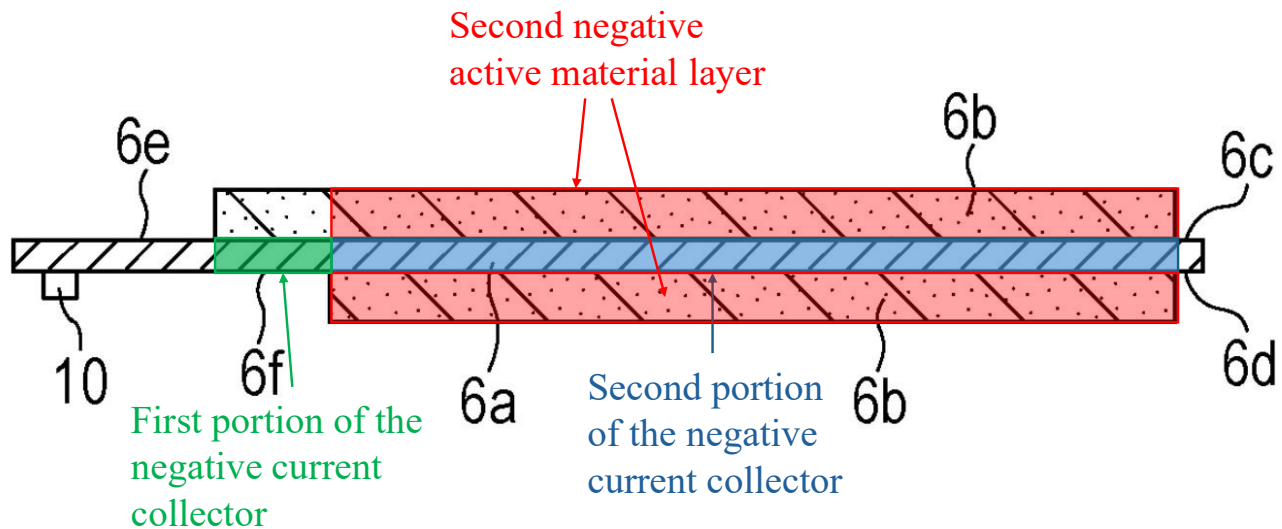
EX1005, Fig. 3(b)*

Manabe's negative electrode has “negative electrode mixture layers 6b disposed on both sides of the negative electrode current collector 6a,” but “portions 6e and 6f” of the negative current collector are “exposed” without any NAML coating. EX1005, ¶[0028]. As shown in Figure 3(b) above, “the exposed portion

6f...extends farther than the exposed portion 6e.” *Id.*; *see also id.*, ¶[0074] (“portion 6e...having a width of 23.0 mm was exposed on one side, and a portion 6f...having a width of 76.0 mm was exposed on the other side.”). Therefore, a portion of the negative current collector (highlighted in green) has the first NAML (highlighted in red) coated on only one side. EX1003, ¶81.

4. [1.3]: “a second negative active material layer, wherein the second negative active material layer is arranged on two sides of a second portion of the negative current collector, wherein the second portion of the negative current collector is different from the first portion of the negative current collector;”

Manabe discloses or suggests this element. EX1003, ¶¶82-83. Specifically, Manabe’s negative electrode has a *second negative active material layer* (negative electrode mixture layer 6b) *arranged on two sides* (top and bottom) *of a second portion* (highlighted blue double-sided-coated portion) *of the negative current collector* (negative electrode current collector 6a) that is *different from the first portion* (highlighted green single-sided-coated portion):



EX1005, Fig. 3(b)*

Manabe's negative electrode has "negative electrode mixture layers 6b disposed on both sides of the negative electrode current collector 6a." EX1005, ¶¶[0028], [0074]. As illustrated above, the blue-highlighted second portion of the negative current collector—different from the green-highlighted first portion—has NAML coated on two sides (highlighted in red). Thus, Manabe discloses or suggests this claim element. EX1003, ¶83.

5. [1.4]: "wherein a ratio of a weight per unit area of the first negative active material layer to a weight per unit area of the second negative active material layer on the negative current collector is 0.47 to 0.52, and"

Manabe discloses or inherently suggests this element. EX1003, ¶¶84-90. Specifically, Manabe discloses a *ratio of a weight per unit area of the first negative active material layer* (negative electrode mixture layers 6b) *to a weight per unit area*

of the second negative active material layer (negative electrode mixture layers 6b) on the negative current collector (negative electrode current collector 6a) is 0.47 to 0.52 (0.5).

Manabe inherently discloses the weight per unit area (i.e., coating weight) of its NAMLs. EX1003, ¶85. Multiplying the compaction density of the NAML by its thickness gives the coat weight. *Id.* Manabe teaches the thickness and compaction densities of the NAMLs. EX1005, ¶[0058]. With these properties known, the coating weight—and ratio of coating weights—is readily determined: Ratio = ((First NAML density) x (First NAML thickness)) ÷ ((Second NAML density) x (Second NAML thickness)). EX1003, ¶85.

Manabe's first and second NAMLs have the same compaction density and thickness. EX1003, ¶86. Manabe teaches the “density of the active material in the negative electrode mixture layers is preferably 1.3 to 1.9 g/cm³” and “the thickness of the negative electrode mixture layers is preferably 40 to 120µm...per side of the negative electrode current collector.” EX1005, ¶[0058].⁶ Thus, a POSITA would have understood the density and thickness values apply equally to each coated side of the negative electrode current collector. EX1003, ¶86. Because the first NAML is on only one side of the current collector, whereas the second NAML is on two sides,

⁶ All emphases through the Petition have been added unless otherwise stated.

the math simplifies to: Ratio = ((NAML thickness) x (1 side)) ÷ ((NAML thickness) x (2 sides)). EX1003, ¶86. Therefore, Manabe's ratio of the weight per unit area of the first NAML to the second NAML is inherently 0.5, within the claimed range. *Id.*

Manabe's examples confirm the 0.5 ratio of coating weights. EX1003, ¶87. For Example 1, the "thickness" of the NAMLs is "77.3 µm per side" and the "density was 1.65 g/cm³." EX1005, ¶[0074]. Thus, the coating weight for the first NAML is 12.75 mg/cm² (77.3 µm x 1.65g/cm³ = 0.01275g/cm²) and the coating weight for the second NAML is 25.5 mg/cm² (77.3 µm x 2 x 1.65g/cm³ = 0.0255g/cm²), resulting in a ratio of 0.5 (12.75 mg/cm² ÷ 25.5 mg/cm² = 0.5). EX1003, ¶87.

Example 2 has a thickness of "80.5 µm per side" and the "density was 1.60 g/cm³." EX1005, ¶[0078]. Thus, the coating weight for the first NAML is 12.88 mg/cm² (80.5 µm x 1.60g/cm³ = 0.01288g/cm²) and the coating weight for the second NAML is 25.76 mg/cm² (80.5 µm x 2 x 1.60g/cm³ = 0.02576g/cm²), resulting in a ratio of 0.5 (12.88 mg/cm² ÷ 25.76 mg/cm² = 0.5). EX1003, ¶88.

Likewise, Example 3's thickness is "76.5 µm per side" and the compaction density is the same as Example 1: 1.65 g/cm³. EX1005, ¶[0079] ("battery was fabricated in the same manner as in EXAMPLE 1" except for noted changes). Thus, the coating weight for the first NAML is 12.62 mg/cm² (76.5 µm x 1.65g/cm³ = 0.01262g/cm²) and the coating weight for the second NAML is 25.24 mg/cm² (76.5

$\mu\text{m} \times 2 \times 1.65\text{g}/\text{cm}^3 = 0.02524\text{g}/\text{cm}^2$), resulting in a ratio of 0.5 ($12.62 \text{ mg}/\text{cm}^2 \div 25.24 \text{ mg}/\text{cm}^2 = 0.5$). EX1003, ¶89.

Accordingly, Manabe discloses a ratio of the weight per unit area of the first NAML to the second NAML of 0.5, satisfying this claim limitation.

6. [1.5]: “a ratio of a compacted density of the first negative active material layer to a compacted density of the second negative active material layer is 0.9 to 1.1;”

Manabe discloses or suggests this element. EX1003, ¶¶91-92. Specifically, Manabe discloses a *ratio of a compacted density (density) of the first negative active material layer (negative electrode mixture layers 6b) to a compacted density (density) of the second negative active material layer (negative electrode mixture layers 6b) between 0.9 to 1.1 (1.0)*.

As explained above, Manabe discloses a uniform density (i.e., *compacted density*)⁷ for the negative electrode mixture layers. *Supra* Section VIII.B.5; EX1003,

⁷ “Compacted density” is the density of the NAML in the final negative electrode, after the NAML has been cold-pressed to the surface of the current collector. EX1001, 4:47-41; EX1003, ¶92 n.7. Manabe discloses that its negative electrode mixture layer is formed by rolling (i.e., via a rolling press) the negative electrode mixture slurry on the surface of the current collector. EX1005, ¶[0051].

¶92. Specifically, the “density of the active material in the negative electrode mixture layers is preferably 1.3 to 1.9 g/cm³.” EX1005, ¶[0058]. This density parameter applies to the negative electrode mixture layers generally—Manabe does not disclose any difference in density between the first and second NAMLs. Accordingly, a POSITA would understand the disclosed single compaction density applies equally to both the first and second NAMLs. EX1003, ¶92.

Manabe’s examples confirm this understanding, as each uses a single density for both negative electrode mixture layers. EX1005, ¶¶[0074], [0078]-[0079].

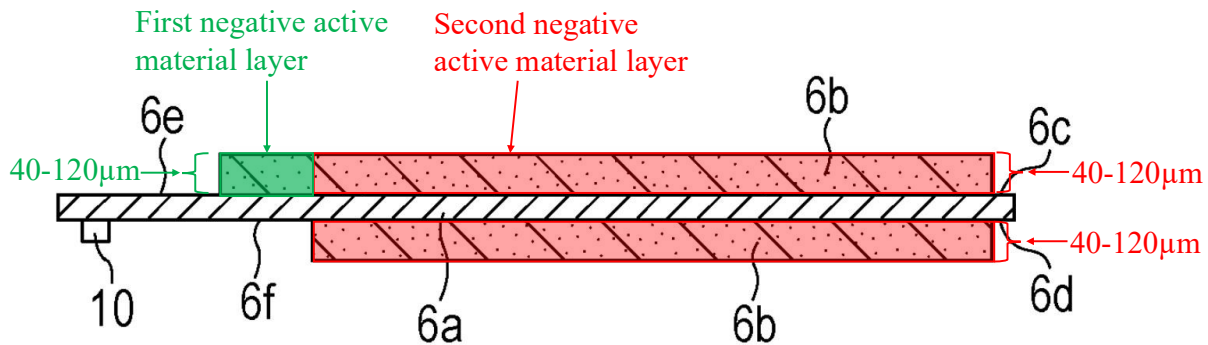
Accordingly, because the compacted density of the first NAML is the same as the compacted density of the second NAML, the ratio of the compacted densities is 1.0. EX1003, ¶92. Thus, Manabe discloses this claim element.

7. **[1.6]: “wherein a thickness of the first negative active material layer is 40 μm to 60 μm, and a thickness of the second negative active material layer on each of the two sides of the second portion is 40 μm to 60 μm.”**

Manabe discloses or suggests this element. EX1003, ¶¶93-95. Specifically, Manabe discloses the *thickness of the first negative active material layer* (negative electrode mixture layer 6b, highlighted in green) *and the second negative active*

Therefore, the density of Manabe’s negative electrode mixture layer is the “compacted density.” EX1003, ¶92 n.7.

material layer (negative electrode mixture layers 6b, highlighted in red) on each of the two sides of the second portion can be 40 μm to 60 μm (40 to 120 μm):



EX1005, Fig. 3(b)*

Figure 3(b), as annotated above, demonstrates the thickness of the first NAML is the same as the thickness of one side of the second NAML, which is the same as the thickness of the second NAML on the opposite side of the current collector. EX1003, ¶94. Manabe’s general description confirms this: “the thickness of the negative electrode mixture layers is preferably 40 to 120 μm ...per side of the negative electrode current collector.” EX1005, ¶[0058]. Manabe’s examples further confirm that a single thickness value applies to the NAML on each side of the current collector. *See* Section VIII.B.5 (citing EX1005, ¶¶[0074], [0078]-[0079]); EX1003, ¶94. Therefore, Manabe’s thickness range of 40 to 120 μm per side applies to the first NAML and each side of the second NAML.

Because Manabe’s disclosed range of thicknesses overlaps the claimed range, this claim element is rendered obvious. *E.I. du Pont*, 904 F.3d at 1006.

C. DEPENDENT CLAIM 2

1. [2.1]: “The negative electrode according to claim 1, the weight per unit area of the first negative active material layer on the first portion is 65 g/m² to 130 g/m², and the weight per unit area of the second negative active material layer on the second portion is 130 g/m² to 260 g/m². ”

Manabe discloses or suggests this claim. EX1003, ¶¶96-97. Specifically, Manabe discloses the *weight per unit area of the first negative active material layer* (negative electrode mixture layers 6b) *on the first portion* can be between 65 g/m² to 130 g/m² (52-228 g/m²) and the *weight per unit area of the second negative active material layer* (negative electrode mixture layers 6b) *on the second portion* can be between 130 g/m² to 260 g/m² (104-456 g/m²).

As explained, Manabe does not expressly disclose coating weights of the NAMLs but does disclose the thickness and compaction densities which directly yield the coating weights. *See* Section VIII.B.5; EX1003, ¶97. Further, the thickness of the first NAML is the same as thickness of each individual side of the second NAML (*see* Section VIII.B.7) and the compaction density is uniform throughout (*see* Section VIII.B.6). EX1003, ¶97. Manabe discloses the density ranges from 1.3-1.9 g/cm³ and the thickness ranges from 40-120 µm per side. EX1005, ¶[0058]. Therefore, Manabe inherently discloses a range of coating weights of 52-228 g/m² per side (1.3 g/cm³ x 40 µm = 52g/m²; 1.9 g/cm³ x 120 µm = 228g/m²). EX1003, ¶97. As the first NAML is coated only on one side of the negative current collector,

its coating weight is 52-228 g/m². *Id.* As the second NAML is coated on both sides, its coating weight is double: 104-456 g/m². *Id.* Thus, Manabe discloses coating weight ranges overlapping the claimed ranges, rendering this claim element obvious. *E.I. du Pont*, 904 F.3d at 1006.

D. DEPENDENT CLAIM 3

1. [3.1]: “The negative electrode according to claim 1, wherein the first negative active material layer and the second negative active material layer each independently comprise a silicon-based material and graphite, wherein the silicon-based material is selected from the group consisting of silicon oxide, silicon carbon, and a combination thereof.”

Manabe discloses or suggests this claim. EX1003, ¶¶98-101. Specifically, Manabe discloses the *first negative active material layer* (negative electrode mixture layers 6b) *and second negative active material layer* (negative electrode mixture layers 6b) *each independently comprise a silicon-based material* (silicon compound) *and graphite* (carbon material, graphite, natural graphite, artificial graphite, graphitized mesophase carbon) and the *silicon-based material* (silicon compound) *is silicon oxide* (silicon oxide, SiO_x).

The first negative active material layer and the second negative active material layer each independently comprise: Manabe coats both sides of the negative current collector with a single negative electrode active material. EX1005, ¶[0011] (describing “[t]he negative electrode mixture layer” used in the negative

electrode); [0073] (“the negative electrode mixture slurry was applied to *both sides* of a...current collector.”); *see also* Section VIII.B.5. Thus, Manabe’s first NAML and second NAML each comprise the same negative electrode active material. EX1003, ¶99.

Graphite: “The negative electrode active material includes a carbon material” which can be “graphites (such as natural graphite, artificial graphite and graphitized mesophase carbon).” EX1005, ¶[0052]. Therefore, Manabe discloses the first NAML and second NAML comprise graphite. EX1003, ¶100.

Silicon compound is silicon oxide: “The negative electrode active material includes ... a silicon compound” which can be “silicon and silicon-containing compounds such as silicon oxides SiO_x ($0.05 < x < 1.95$)” and is “preferably SiO_x ($0.5 \leq x \leq 1.5$).” EX1005, ¶[0052]. Manabe renders this claim obvious. EX1003, ¶101.

E. DEPENDENT CLAIM 4

1. **[4.1]: “The negative electrode according to claim 3, wherein a weight of the silicon-based material in the first negative active material layer and the second negative active material layer is greater than or equal to 5% and less than 100%, based on a total weight of the silicon-based material and the graphite.”**

Manabe discloses or suggests this claim. EX1003, ¶¶102-103. Specifically, Manabe discloses the *weight* (mass %) of the *silicon-based material* (silicon compound, silicon oxide, SiO_x) is *greater than or equal to 5%* (not less than 5 mass

%) and less than 100% (less than 30 mass %) based on a total weight of the silicon-based material and the graphite (carbon material, graphite, natural graphite, artificial graphite, graphitized mesophase carbon).

Manabe's first and second NAMs comprise the same negative electrode active material. See Section VIII.D.1; EX1003, ¶103. To "attain enhancements in cycle characteristics and battery safety," silicon oxide preferably comprises between 2-50% "of the total mass of the carbon material and SiO_x taken as 100 mass %." EX1005, ¶[0053]. More preferably, silicon oxide is 5-30 mass %. *Id.* Manabe's preferred range substantially overlaps the claimed range and Manabe's more preferred range falls within the claimed range. EX1003, ¶103.

F. DEPENDENT CLAIM 7

- 1. [7.1]: "The negative electrode according to claim 3, wherein the silicon-based material further comprises a carbon coating layer."**

Manabe discloses or suggests this claim. EX1003, ¶104. Specifically, Manabe discloses the *silicon-based material* (silicon oxide, SiO_x) *further comprises a carbon coating layer* (coated with carbon). Manabe coats the "surface of SiO_x...with carbon" to improve the poor conductivity of SiO_x. EX1005, ¶[0055].

G. DEPENDENT CLAIM 8

1. **[8.1]: “The negative electrode according to claim 3, wherein the first negative active material layer and the second negative active material layer each independently comprise a binder and a conductive agent;”**

Manabe discloses or suggests this claim element. EX1003, ¶¶105-106. Specifically, Manabe discloses the *first negative active material layer* (negative electrode mixture layers 6b) *and second NAML* (negative electrode mixture layers 6b) *each independently comprise a binder* (binder, binding agent) *and a conductive agent* (conductive auxiliary).

Manabe uses the same negative electrode mixture layer for both the first and second NAMLs. *See* Section VIII.D.1; EX1003, ¶106. Manabe’s negative electrode mixture layers contain a “binder” and may contain additional “additives such as a conductive auxiliary” (i.e., conductive agent). EX1005, ¶[0051]. Thus, Manabe discloses this element.

2. **[8.2]: “wherein the binder comprises a material selected from the group consisting of polyacrylate, polyimide, polyamide, polyamideimide, polyvinylidene fluoride, styrene-butadiene rubber, sodium alginate, polyvinyl alcohol, polytetrafluoroethylene, polyacrylonitrile, sodium carboxymethyl cellulose, potassium carboxymethyl cellulose, and a combination thereof; and”**

Manabe discloses or suggests this claim element. EX1003, ¶¶107-108. Specifically, Manabe discloses the *binder* (binder) can be *polytetrafluoroethylene* (polytetrafluoroethylene, PTFE), *polyvinylidene fluoride* (polyvinylidene fluoride,

PVDF), *styrene-butadiene rubber* (styrene-butadiene rubber), *or a combination thereof*.

Manabe discloses the binder can be any “known binding agent,” and lists examples including “fluororesins such as **polytetrafluoroethylene (PTFE)**, **polyvinylidene fluoride (PVDF)**...and rubbery materials such as **styrene-butadiene rubber**.” EX1005, ¶[0044].⁸ Manabe further discloses “binders may be used singly, or two or more may be used in combination.” *Id.* Thus, Manabe discloses this element.

3. [8.3]: “the conductive agent comprises a material selected from the group consisting of conductive carbon black, acetylene black, Ketjen black, graphene, and a combination thereof.”

Manabe discloses or suggests this element. EX1003, ¶¶109-110. Specifically, Manabe discloses the *conductive agent* (conductive auxiliary) *comprises a material selected from the group consisting of conductive carbon black* (carbon blacks), *acetylene black* (acetylene black), *and a combination thereof*.

⁸ This disclosure refers to binders in the positive electrode mixture layer, but Manabe uses the same binders in the negative electrode mixture layer. EX1005, ¶[0057].

Manabe discloses the conductive agent can be any “known material,” and lists examples including “**carbon blacks** such as **acetylene black**.” EX1005, ¶[0042].⁹ Manabe further discloses the “conductive auxiliaries may be used singly, or two or more may be used in combination.” *Id.* Therefore, Manabe discloses this element.

H. DEPENDENT CLAIM 9

1. [9.1]: “The negative electrode according to claim 8, wherein based on a total weight of the first negative active material layer, the total weight of the silicon-based material and the graphite in the first negative active material layer is 94% to 96%, a weight of the binder is 2.8% to 5.0%, and a weight of the conductive agent is 0.4% to 1.6%; and based on a total weight of the second negative active material layer, the total weight of the silicon-based material and the graphite in the second negative active material layer is 94% to 96%, the weight of the binder is 2.8% to 4.0%, and the weight of the conductive agent is 0.4% to 1.6%.”

Manabe discloses or suggests this claim. EX1003, ¶¶111-123. Specifically, Manabe discloses that, *based on a total weight (mass) of the first negative active material layer (negative electrode mixture layers 6b), the total weight (mass %) of the silicon-based material (silicon oxide, SiO_x) and the graphite (graphite) (collectively, negative electrode active material) in the first negative active material*

⁹ This disclosure refers to the conductive auxiliaries used in the positive electrode mixture layer, but Manabe teaches using the same conductive auxiliaries in the negative electrode mixture layers. EX1005, ¶[0057].

layer can be between 94% to 96% (82.3% to 99.5% or 89.7% to 99.5%), a weight (mass) of the binder (binder) can be between 2.8% to 5.0% (0.01% to 4.74%), and a weight of the conductive agent (conductive auxiliary) can be between 0.4% to 1.6% (0.41% to 1.48%). Further, Manabe discloses that, based on a total weight of the second NAML (negative electrode mixture layers 6b), the total weight of the silicon-based material and the graphite in the second NAML can be between 94% to 96% (82.3% to 99.5% or 89.7% to 99.5%), the weight of the binder can be between 2.8% to 4.0% (0.01% to 4.74%), and the weight of the conductive agent can be between 0.4% to 1.6% (0.41% to 1.48%).

Manabe uses the same negative electrode mixture layer for both the first and second NAMLs. *See* Section VIII.D.1. Therefore, the ratio of components for the first and second NAMLs is the same. EX1003, ¶120.

Binder: The binder's lower limit "is not particularly limited" and may be as low as 0.01 mass % and is "preferably not more than 5 mass %...relative to the [negative] electrode active material taken as 100 mass %." EX1005, ¶[0045].¹⁰ In

¹⁰ Manabe explains that the "amounts of the components" including binder and conductive auxiliaries "relative to the negative electrode active material may be selected from the same ranges as mentioned with respect to the positive electrode." EX1005, ¶[0057].

terms of a percentage of the total weight of the NAML, this equates to 0.01% to 4.74%. EX1003, ¶¶113-119, 121. Thus, Manabe's binder amount substantially overlaps the claimed ranges for both the first and second NAMLs. EX1003, ¶121.

Conductive agent: The conductive auxiliary is “preferably not less than 0.5 mass % and not more than 1.5 mass %.” EX1005, ¶[0043]. In terms of a percentage of the total weight of the NAML, this equates to 0.41% to 1.48%. EX1003, ¶¶112, 116-119, 122. Thus, Manabe's conductive agent substantially overlaps the claimed ranges for both the first and second NAMLs. EX1003, ¶122.

If these components are present in the negative electrode mixture layer at their highest preferred mass %, then the mass % of active material (silicon-based material and graphite) is 89.69 mass %. EX1003, ¶123. If the components are present at their lowest preferred mass %, then the silicon-based material and graphite are 99.5 mass %. *Id.* Alternatively, if the binder and thickener are a single component and the composition range applies to them collectively, the maximum active material percentage is 99.5 mass %, while the minimum is 93.90 mass %. *Id.* Either way, Manabe's component ranges overlap the claimed ranges, rendering this claim obvious. *E.I. du Pont*, 904 F.3d at 1006.

I. INDEPENDENT CLAIM 10

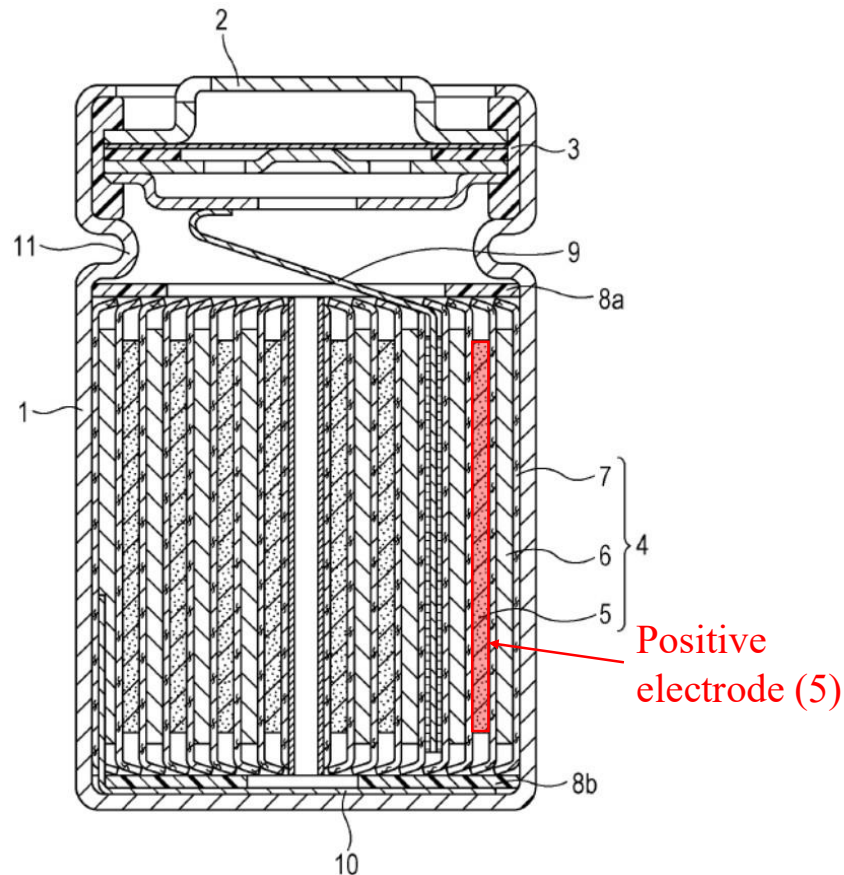
1. [10.pre]: “An electrochemical apparatus, comprising:”

Manabe discloses or suggests this claim element. EX1003, ¶¶124-125. Specifically, Manabe discloses an *electrochemical apparatus* (nonaqueous electrolyte secondary battery).

Manabe discloses a “nonaqueous electrolyte secondary battery.” EX1005, Abstract, ¶¶[0010]-[0012]. Nonaqueous electrolyte secondary batteries include lithium-ion batteries, the same electrochemical apparatus the ’082 Patent is directed to. EX1003, ¶125; EX1001, 7:15-19.

2. [10.1]: “a positive electrode;”

Manabe discloses or suggests this claim element. EX1003, ¶¶126-127. Specifically, Manabe discloses a *positive electrode* (positive electrode 5):

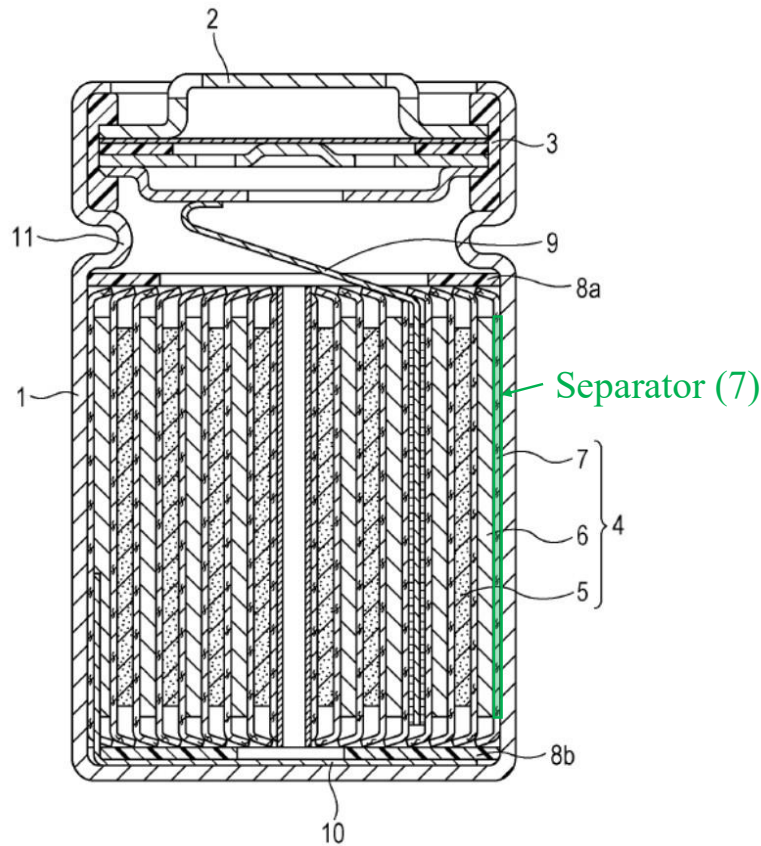


EX1005, Fig. 1*

Manabe’s electrochemical apparatus includes a “positive electrode 5.” EX1005, ¶[0023]. Manabe discloses additional details regarding its positive electrode, including components, materials, dimensions, etc. *Id.*, ¶¶[0030]-[0049]. Manabe’s examples each include a positive electrode. *Id.*, ¶¶[0070], [0071], [0078]-[0081].

3. [10.2]: “a separator; and”

Manabe discloses or suggests this claim element. EX1003, ¶¶128-129. Specifically, Manabe discloses a *separator* (separator 7):



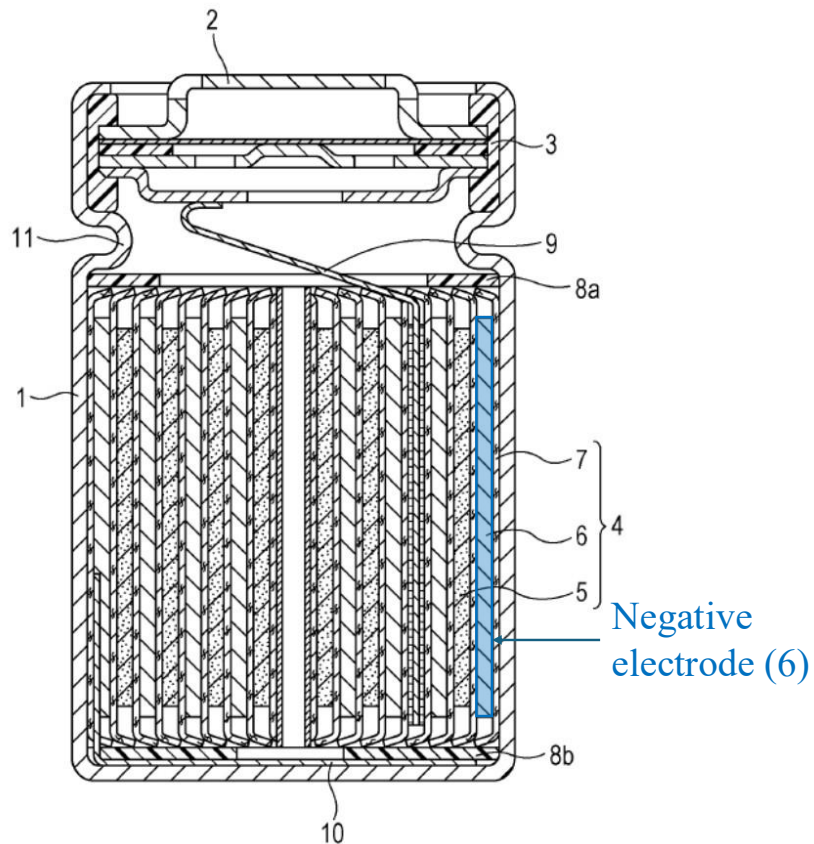
EX1005, Fig. 1*

Manabe's electrochemical apparatus includes a "separator 7...interposed between" the positive and negative electrodes. EX1005, ¶[0023]. Manabe discloses example separators. *Id.*, ¶[0062]. Manabe's example batteries each include a separator. *Id.*, ¶¶[0075], [0078]-[0080].¹¹

¹¹ Examples 4 and 5 were prepared in the same manner as Example 3 and thus contain a separator with a length of 707.5mm. EX1005, ¶¶[0079]-[0081].

4. [10.3]: “a negative electrode; wherein the negative electrode comprises”

Manabe discloses or suggests this claim element. EX1003, ¶130. Specifically, Manabe’s electrochemical apparatus includes a *negative electrode* (negative electrode 6):



EX1005, Fig. 1*

See Section VIII.B.1; EX1003, ¶130.

5. [10.4]: “a negative current collector;”

Manabe discloses or suggests this claim element. EX1003, ¶131. See Section VIII.B.2.

6. **[10.5]: “a first negative active material layer, wherein the first negative active material layer is arranged on one side of a first portion of the negative current collector; and”**

Manabe discloses or suggests this claim element. EX1003, ¶132. *See* Section

VIII.B.3.

7. **[10.6]: “a second negative active material layer, wherein the second negative active material layers are arranged on two sides of a second portion of the negative current collector, wherein the second portion of the negative current collector is different from the first portion of the negative current collector,”**

Manabe discloses or suggests this claim element. EX1003, ¶133. *See* Section

VIII.B.4.

8. **[10.7]: “wherein a ratio of a weight per unit area of the first negative active material layer to a weight per unit area of the second negative active material layer on the negative current collector is 0.47 to 0.52, and”**

Manabe discloses or suggests this claim element. EX1003, ¶134. *See* Section

VIII.B.5.

9. **[10.8]: “a ratio of a compacted density of the first negative active material layer to a compacted density of the second negative active material layer is 0.9 to 1.1;”**

Manabe discloses or suggests this claim element. EX1003, ¶135. *See* Section

VIII.B.6.

- 10. [10.9]: “wherein a thickness of the first negative active material layer is 40 μm to 60 μm , and a thickness of the second negative active material layer on each of the two sides of the second portion is 40 μm to 60 μm .”**

Manabe discloses or suggests this claim element. EX1003, ¶136. *See* Section VIII.B.7.

J. DEPENDENT CLAIM 11

- 1. [11.1]: “An electronic apparatus, comprising the electrochemical apparatus according to claim 10.”**

Manabe discloses or suggests this claim. EX1003, ¶¶137-138. Specifically, Manabe discloses an *electronic apparatus* (cellphones, laptop computers, smartphones, power supplies) *comprising the electrochemical apparatus* (nonaqueous electrolyte secondary battery) *of claim 10*.

Manabe’s battery “is expected to be applied to...cellphones, laptop computers and smartphones, power supplies...for driving of BEV, PHEV and HEV, and storage-related power supplies.” EX1005, ¶[0126]. Each is an electronic apparatus. EX1003, ¶138.

K. DEPENDENT CLAIM 12

1. [12.1]: “The electrochemical apparatus according to claim 10, the weight per unit area of the first negative active material layer on the first portion is 65 g/m² to 130 g/m², and the weight per unit area of the second negative active material layer on the second portion is 130 g/m² to 260 g/m².”

Manabe discloses or suggests this claim. EX1003, ¶139. *See* Sections VIII.C.1, VIII.I.

IX. GROUND 2: MANABE AND INABA RENDER OBVIOUS CLAIMS 5 AND 6

A. OVERVIEW OF INABA

Inaba discloses a non-aqueous rechargeable battery with “high capacity and favorable storage characteristics.” EX1007, ¶[0001]. Silicon and tin have been identified as alternatives to carbons materials, such as graphite, that can improve capacity. EX1007, ¶[0003]. In particular, SiO_x possesses excellent loading characteristics. *Id.* But SiO_x suffers from “significant volume expansion and shrinkage during charge-discharge reactions.” *Id.*, ¶[0004]. Prior proposed solutions include “limiting the utilization rate of SiO_x” in the negative electrode by creating composite particles where SiO_x (with Si being in a crystalline state within the SiO₂) is the core and carbon covers the core. *Id.*, ¶¶[0005]-[0007].

Inaba optimizes the negative electrode active material layer, increasing capacity and improving storage characteristics. EX1007, ¶[0008]. The negative electrode active material further contains a graphitic carbon material. *Id.*, ¶[0010].

Inaba constrains the particle size distribution of the material containing silicon and oxygen, greatly improving battery storage characteristics. EX1007, ¶[0013]. Particle sizes are measured using a laser scattering particle size distribution analyzer, resulting in cumulative fractions in a volume-based distribution. *Id.*, ¶¶[0009], [0019]-[0021]. The particles should have a Dv50 of 6-10µm. *Id.*, ¶¶[0009], [0015]. Below 6 µm, capacity degradation likely occurs when the battery is stored in a charged state. *Id.*, ¶[0016]. Above 10 µm, battery capacity is reduced. *Id.* Further, Inaba states a Dv10 of 4 µm or greater is preferred for more favorable storage characteristics. *Id.*, ¶[0020]. To avoid damaging the separator and to increase battery reliability, a Dv90 of 14 µm or less is preferred. *Id.*, ¶[0021].

Though the material containing silicon and oxygen can be a composite oxide of silicon with another metal, silicon dispersed in an amorphous SiO₂ matrix is preferred. EX1007, ¶¶[0022]-[0023]. The material, referred to as SiO_x, preferably has a molar ratio of SiO₂ matrix to dispersed silicon such that x is between 0.5 and 1.5. *Id.*, ¶[0023]. The silicon is in either a microcrystalline or amorphous phase. *Id.*, ¶[0022].

To increase conductivity, the surfaces of the SiO_x particles are coated with carbon, forming a composite. EX1007, ¶[0024]. Coating the carbon material on SiO_x is preferred over simply mixing SiO_x with carbon, as coating leads to a better conductive network and therefore improved load characteristics, higher capacity, and charge-discharge cycle characteristics. *Id.*, ¶¶[0024], [0026]. SiO_x and carbon composite particles may form larger aggregates (granules), which may include additional added carbon material. *Id.*, ¶¶[0025]-[0026], [0042]-[0043]. The coating carbon material is preferably “low-crystallinity carbon, carbon nanotubes, vapor-phase growth carbon fibers,” or similar materials. *Id.*, ¶[0028]. “[C]arbon black (including acetylene black and Ketjen black), artificial graphite, graphitizable carbon, and non-graphitizable carbon” are preferred as they have high electrical conductivity, high liquid retention, and easily maintain contact to SiO_x particles through expansion and shrinking cycles. *Id.*, ¶¶[0029]-[0030]. Graphitic carbon can be used as a negative electrode active material, and the carbon coated composite SiO_x particles are combined with the additional carbon active material. *Id.*, ¶¶[0030], [0058].

Within the SiO_x carbon composite, the carbon material is 4.7-33.3 mass% of the total SiO_x carbon composite, more preferably 9.1-28.6 mass%. EX1007, ¶[0035];

EX1003, ¶145.¹² Inaba discloses methods for producing both the SiO_x material and the SiO_x carbon composite. *Id.*, ¶¶[0036]-[0051].

Inaba uses Raman spectroscopy analysis on the SiO_x carbon composite to determine the ratio of the silicon peak and carbon peak. EX1007, ¶¶[0052]-[0054]. To ensure the SiO_x particle surface is sufficiently covered by carbon material, thereby improving conductivity of the composite material, the ratio is preferably 0.25 or less. *Id.*

The negative electrode includes a current collector with a negative electrode mixture layer on one or both sides. EX1007, ¶[0056]. The negative electrode mixture layer comprises negative active material, graphitic carbon, and binder. *Id.* ¶¶[0056]-[0058]. Graphitic carbon mitigates the large volume changes experienced by SiO_x during charge and discharge cycles. *Id.*, ¶[0058]. The SiO_x carbon composite is 1-20 mass% of the total negative active materials (SiO_x carbon composite plus graphite), more preferably 3-15 mass%. *Id.*, ¶[0060]. The SiO_x carbon composite plus graphite is 80-99 mass% of the total negative electrode mixture layer. *Id.*, ¶[0065].

Inaba includes binder material in the negative electrode mixture layer. EX1007, ¶[0061]. Example binders include “polyvinylidene fluoride (PVDF),

¹² Inaba specifies ratios of SiO_x to carbon, which have been converted into percentages. EX1003, ¶145.

polytetrafluoroethylene (PTFE), styrene-butadiene rubber (SBR), and carboxymethyl cellulose (CMC), and” similar materials. *Id.* The binder is 1-20 mass% of the negative electrode mixture layer. *Id.*, ¶[0065].

Inaba includes additional conductive material in the negative electrode mixture layer. EX1007, ¶[0062]. The conductive material is not limited, but examples “include carbon black (thermal black, furnace black, channel black, Ketjen black, acetylene black, and the like), carbon fibers, metal powders (copper, nickel, aluminum, silver, and the like), metal fibers, and polyphenylene derivatives.” *Id.* “[C]arbon black is preferred, and Ketjen black and acetylene black are more preferred.” *Id.* The Dv50 of the conductive material is between 0.01-10µm, more preferably 0.02-5µm. *Id.*, ¶[0063]. The conductive material is 1-10 mass% of the negative electrode mixture layer. *Id.*, ¶[0065].

The negative electrode mixture layer is 10-100µm thick per side of the current collector. EX1007, ¶[0065]. The density of the negative electrode mixture layer is preferably 1.0-1.9 g/cm³. *Id.*

The current collector is commonly copper foil, but may also be nickel foil, a punching metal, a mesh, an expanded metal, or a similar material. EX1007, ¶[0066]. To obtain both high energy density and mechanical strength, Inaba’s current collector is 5-30 µm thick. *Id.*

Inaba discloses details of the positive electrode (¶¶[0067]-[0072]), separator (¶¶[0073]-[0103]), and the nonaqueous electrolyte (¶¶[0104]-[0127]). EX1007. The form of the battery is not limited. *Id.*, ¶[0128].

Inaba discloses experimental procedures for constructing and testing example batteries. EX1007, ¶¶[0148]-[0165]. Table 1 summarizes the composition of the example batteries, while Table 2 summarizes the test results. *Id.*, ¶¶[0165]-[0167]. The results confirm examples with the desired SiO_x carbon composite Dv50 have excellent storage characteristics. *Id.*, ¶[0168]. All examples with excellent storage characteristics had the ratio of the Raman spectroscopy silicon peak to carbon peak below the 0.25 value taught by Inaba. *Id.*, ¶[0167], Table 1, Table 2.

B. DEPENDENT CLAIM 5

- 1. [5.1]: “The negative electrode according to claim 3, wherein a form of the silicon-based material comprises a crystalline state, an amorphous state, or a combination thereof,”**

Manabe does not expressly disclose the form of its silicon-based material. However, a POSITA would have known there are only two possible states of molecular (or atomic) scale order of these silicon compounds: “crystalline” and “amorphous.” EX1003, ¶154. Therefore, the silicon compounds taught by Manabe are necessarily crystalline or amorphous. *Id.* Thus, Manabe inherently discloses this claim element.

If PO (incorrectly) argues express disclosure is needed, Inaba discloses silicon oxide may be in crystalline or amorphous state, or a combination thereof and provides motivation to modify Manabe's silicon oxide material to be in Inaba's preferred structure of fine Si phase dispersed in an amorphous SiO₂ matrix. EX1003, ¶155.

a. Inaba discloses element [5.1]

Inaba discloses or suggests this element. EX1003, ¶¶156-158. Specifically, Inaba discloses *the form of the silicon-based material* (composite of silicon and silicon oxide, SiO_x) *comprises a crystalline state* (crystalline state or microcrystalline), *an amorphous state* (amorphous), *or a combination thereof*.

Inaba's negative electrode active material contains "Si and O as constituent elements." EX1007, ¶[0022]. As stated above, there are only two possible states of molecular (or atomic) scale order of these silicon compounds: "crystalline" and "amorphous." EX1003, ¶157. Therefore, the silicon compounds taught by Inaba are necessarily crystalline or amorphous.

Moreover, Inaba prefers the structure of the silicon compounds to be an amorphous matrix of silicon oxide (SiO₂) in which smaller particles of silicon (Si) are dispersed, and these silicon particles may be "microcrystalline or amorphous phases." EX1007, ¶¶[0022], [0023] "Microcrystalline" phases of silicon are particles or regions of crystalline silicon that are small. This is consistent with the claimed

“crystalline state” for the silicon-based material. EX1003, ¶158. Accordingly, Inaba discloses silicon oxide, as used in a negative electrode active material, can be in a crystalline state in addition to an amorphous state, and crystalline and amorphous phases of Si and SiO₂ coexist within the same particles. *Id.*

b. Rationale to combine Manabe and Inaba

A POSITA would have been motivated, with a reasonable expectation of success, to modify Manabe’s silicon-based material to have the preferred structure (amorphous matrix of SiO₂ in which smaller particles of silicon are dispersed) taught by Inaba (if not already in that structure), resulting in claim element [5.1]. EX1003, ¶¶159-170; EX1007, ¶[0023].

i. Analogous art

Manabe and Inaba are analogous art to each other and the ’082 Patent, as they all are directed to the same field of endeavor: lithium-ion batteries, and more specifically negative electrodes. *See, e.g.*, EX1001, 1:45-48; EX1005, ¶¶[0011], [0050]-[0061]; EX1007, ¶¶[0001], [0008]-[0011]. Manabe provides a lithium-ion battery exhibiting “excellent high-temperature cycle characteristics as well as having a high capacity and a high output.” EX1005, ¶¶[0010], [0012]. Inaba similarly provides a lithium-ion battery addressing high-temperature performance issues while maintaining high capacity. EX1007, ¶[0168].

ii. Teaching, suggestion, motivation

Inaba teaches, suggests, and motivates a POSITA to modify Manabe's silicon oxide material to be in a structure where a fine Si phase is dispersed in an amorphous SiO₂ matrix (if not already in that structure), resulting in claim element [5.1]. EX1003, ¶¶161-162.

Inaba's negative electrode active material composition "greatly improved" the storage characteristics of the battery. EX1007, ¶[0013]. Inaba's examples showed "excellent storage characteristics of large initial discharge capacity and high capacity retention rate" across all storage conditions, including at high temperatures (45°C for 30 days). *Id.*, ¶[0168]. In contrast, Inaba's comparative examples exhibited either "inferior storage characteristics of poor capacity retention" or "low initial discharge capacity." *Id.*, Table 2, ¶[0169]. Manabe aimed to provide a battery with "excellent high-temperature cycle characteristics" as well as "high capacity." EX1005, ¶¶[0010], [0012]. While Manabe teaches using silicon oxide as a negative electrode active material, it does not teach a specific material structure. Therefore, due to the above stated benefits of Inaba's negative electrode active material, a POSITA would have been motivated to incorporate Inaba's preferred structure into Manabe. EX1003, ¶162.

iii. Use of Known Technique to Improve Similar Devices in the Same Way

A POSITA would have improved Manabe's negative electrode by dispersing silicon in an amorphous SiO₂ (if not already in that structure) as taught by Inaba to enjoy the benefits of Inaba's improved negative electrode. EX1003, ¶¶163-165.

Base device (Manabe's negative electrode): Manabe discloses a negative electrode embodying claim element [5.1] except Manabe does not explicitly disclose the silicon oxide material is in either a crystalline state, amorphous state, or a combination of the two. *See* Section VIII.D; EX1003, ¶164.

Comparable device (Inaba's negative electrode): Inaba's negative electrode contains silicon oxide as an active material, and the silicon oxide may have microcrystalline or amorphous phases of silicon. EX1007, ¶[0022]. Further, Inaba prefers the silicon be "dispersed within an amorphous SiO₂ matrix." *Id.*, ¶[0023]. By using an amorphous SiO₂ matrix, the negative active material is more predictable, stabler, has a better life cycle, and is more compatible with the graphite material. EX1003, ¶165. Through this phase structure, in combination with Inaba's other teachings, the negative electrode improves battery capacity and storage characteristics. EX1007, ¶[0001]. Thus, a POSITA would have been motivated to improve Manabe's negative electrode by using Inaba's amorphous SiO₂ matrix. EX1003, ¶165.

iv. Reasonable expectation of success

A POSITA would have had a reasonable expectation of success in achieving Inaba's SiO_x phase structure in Manabe's negative electrode. EX1003, ¶¶166-170.

Inaba and Manabe both describe negative electrodes for lithium-ion batteries with similar compositions: a current collector coated with negative electrode active material. EX1005, ¶[0051]; EX1007, ¶[0145]. Both disclose copper foil current collectors with a thickness of 5-30 μm . EX1005, ¶¶[0030]¹³, [0050], [0073]; EX1007, ¶[0066].

Both Inaba's and Manabe's negative electrode active materials comprise silicon composite oxides (SiO_x) and graphite at overlapping mass percentages. EX1005, ¶[0053] (5-30% SiO_x , 70-95% graphite); EX1007, ¶¶[0058]-[0060] (3-15% SiO_x , 85-97% graphite). The active material layers have overlapping thicknesses and densities. EX1005, ¶[0058] (thickness of 40-120 μm ; density of 1.3-1.9 g/cm^3); EX1007, ¶[0065] (thickness of 10-100 μm ; density of 1.0-1.9 g/cm^3). Both use binder materials, with common examples including polyvinylidene fluoride (PVDF), polytetrafluoroethylene (PTFE), and styrene-butadiene rubber (SBR). EX1005, ¶¶[0044], [0057]; EX1007, ¶[0061].

¹³ This is in reference to the current collector of the positive electrode, but the same thickness range applies to the negative current collector. EX1005, ¶[0050].

Inaba and Manabe both disclose positive electrodes comprising lithium transition metal oxides. EX1005, ¶¶[0032]-[0033]; EX1007, ¶¶[0067]-[0068]. Both disclose separators that may be polyolefin microporous membranes. EX1005, ¶[0062]; EX1007, ¶[0073]. And both disclose electrolytes comprising lithium salt (including LiPF_6) in a solvent that may comprise ethyl acetate (EC), methyl acetate (MEC), and dimethyl carbonate (DMC). EX1005, ¶¶[0063], [0065]; EX1007, ¶[0149].

Accordingly, a POSITA would have recognized Inaba and Manabe disclose highly similar batteries with highly similar negative electrodes and negative electrode active materials. Thus, a POSITA would have reasonably expected Inaba's silicon compound phase structure to be compatible and achievable in Manabe's negative electrode using only routine skill. EX1003, ¶170.

2. **[5.2]: “wherein the first negative active material layer has a particle size Dv50 of 8.0 μm to 20 μm , and the second negative active material layer has a particle size Dv50 of 8.0 μm to 20 μm .”**

Manabe does not disclose the size distribution of the particles in its NAMLs. Inaba, however, discloses NAML particle sizes falling in the claimed range and provides motivation for a POSITA to modify Manabe's particle sizes. EX1003, ¶¶171-184.

a. Inaba discloses element [5.2]

Inaba discloses or suggests this element. EX1003, ¶¶172-174. Specifically, Inaba discloses that the *first negative active material layer* (negative electrode mixture) *and second negative active material layer* (negative electrode mixture layer) have *particle sizes Dv50 (D_{50%}) of 8.0 μm to 20 μm* (15.65 μm, 15.55 μm).

Inaba's NAML comprises graphite and a silicon oxide (SiO_x) carbon composite. EX1007, ¶¶[0014], [0022]-[0025], [0058]-[0059]. Examples 1-6 each have a NAML comprising 5 parts SiO_x to 95 parts graphite. *Id.*, ¶¶[0143], [0157]. The graphite Dv50¹⁴ is 16 μm for each example. *Id.* For Examples 1 and 3-6, the SiO_x Dv50 is 9 μm.¹⁵ *Id.*, Table 1. Example 2 has a SiO_x Dv50 of 7 μm. *Id.* The Dv50 of the NAML is therefore 15.65μm ((16μm x 0.95) + (9μm x 0.05) = 15.65μm)

¹⁴ Inaba's "D_{50%}" is the "particle size at 50% of a cumulative volume-based fraction" (EX1007, ¶[0019]) which is the same as the claimed Dv50 as both are the median particle size in cumulative volume distribution. *See* EX1001, 9:35-48 ("Dv50 represents a particle size when a volume of a sample reaches 50% of a total volume ... in a volume-based particle size distribution."); EX1003, ¶173 n.14.

¹⁵ As the first and second NAMLs are comprised solely of graphite and SiO_x, and the Dv50 of both are within the claimed range, the Dv50 of the NAMLs in Examples 1, 3-6 must also be within the claimed range. EX1003, ¶174 n.15.

for Examples 1 and 3-6 and $15.55\mu\text{m}$ ($(16\mu\text{m} \times 0.95) + (7\mu\text{m} \times 0.05) = 15.55\mu\text{m}$) for Example 2. EX1003, ¶173. Thus, all Inaba Examples have Dv50s within the claimed range.

If claim [5.2] refers solely to particle sizes of the silicon-based material, Inaba still discloses this element. Inaba's silicon-based material has a "D_{50%} of 6 to 10 μm ." EX1007, ¶[0009]. Additionally, in Inaba's Examples 1 and 3-6, SiO_x has a D_{50%} of 9 μm . *Id.*, Table 1. Thus, Inaba discloses this element under either interpretation. EX1003, ¶174.

b. Rationale to combine Manabe and Inaba

A POSITA would have been motivated, with a reasonable expectation of success, to modify the Dv50 of Manabe's first and second NAMLs to use the Dv50 of Inaba's NAMLs, resulting in claim element [5.2]. EX1003, ¶¶175-184.

i. Analogous art

See Section IX.B.1.b.i; EX1003, ¶176.

ii. Teaching, suggestion, motivation

Inaba teaches, suggests, and motivates a POSITA to modify the Dv50 of Manabe's first and second NAMLs. EX1003, ¶¶177-179.

Inaba teaches controlling Dv50 of the silicon-based material is important to maintaining high capacity and suppressing capacity degradation when storing the battery in a charged state. EX1007, ¶[0015]. Specifically, Dv50 of the silicon-based

material should be 6-10 μm . *Id.* Below that range, “capacity degradation is likely to occur” during charged storage. *Id.*, ¶[0016]. Above that range, the “center of negative electrode active material particles becomes less likely to participate in a charge-discharge reaction” causing reduced capacity. *Id.* Inaba’s test results confirm this. Examples 1-6, all of which have silicon-based material Dv50’s within Inaba’s prescribed range, exhibit “excellent storage characteristics.” *Id.*, ¶[0168], Tables 1-2. In contrast, Comparative Example 1—with a Dv50 of 5 μm —had “inferior storage characteristics.” *Id.*, ¶[0169], Tables 1-2. Comparative Example 4—with a Dv50 of 11 μm for the silicon-based material—had “low initial discharge capacity.” *Id.*, ¶[0169], Tables 1-2. As for graphite particle size, Inaba teaches Dv50 of 16 μm is compatible with the silicon-based material at the prescribed particle sizes, facilitating the “excellent storage characteristics” described above. EX1007, ¶¶[0143], [0166]-[0168]; EX1003, ¶178.

Manabe does not disclose specific particle sizes for its negative electrode mixture layer. Therefore, a POSITA would have been motivated to look to a secondary reference teaching particle sizes for negative electrode active materials. EX1003, ¶179. As excellent storage characteristics and high capacity are desired characteristics for lithium-ion batteries, a POSITA would have been motivated to incorporate the Dv50 of Inaba’s negative electrode active material to improve storage and capacity characteristics. *Id.* A POSITA would have incorporated the

graphite Dv50 of Inaba as a POSITA would have known it is compatible with particles of the negative electrode mixture layer of the size taught by Inaba. *Id.*

iii. Use of Known Technique to Improve Similar Devices in the Same Way

A POSITA would have improved Manabe's negative electrode by using Inaba's particle sizes to enjoy the benefits of Inaba's improved negative electrode. EX1003, ¶¶180-183.

Base device (Manabe's negative electrode): Manabe discloses claim element [5.2] except Manabe does not disclose the particle size distribution of its NAMLs. *See* Section VIII.D. Thus, Manabe leaves open the particle size distribution—including the Dv50—of its NAML materials. EX1003, ¶181.

Comparable device (Inaba's negative electrode): Inaba teaches the Dv50 of negative electrode active materials is important to maintaining high capacity and suppressing capacity degradation when storing the battery in a charged state. EX1007, ¶[0015]. Specifically, the Dv50 of the negative electrode active material should be 6-10 μm . *Id.*; *see* Section IX.B.2.b.ii Thus, a POSITA would have been motivated to improve Manabe's negative electrode by using Inaba's particle size distribution. EX1003, ¶183.

iv. Reasonable expectation of success

A POSITA would have had a reasonable expectation of success in modifying Manabe's negative active material particles to have Inaba's particle size distribution for the same reasons stated above. Section IX.B.1.b.iv; EX1003, ¶184.

C. DEPENDENT CLAIM 6

1. **[6.1]: “The negative electrode according to claim 3, wherein for the silicon-based material, a ratio of a peak height at a wavenumber of $500\text{ cm}^{-1} \pm 10\text{ cm}^{-1}$ to a peak height at a wavenumber of $1350\text{ cm}^{-1} \pm 10\text{ cm}^{-1}$ in a Raman spectrum is greater than 0.”**

Manabe does not disclose the ratio of peak heights in a Raman spectrum for the silicon-based material. Inaba, however, discloses the claimed ratio and provides motivation to configure Manabe's silicon-based material to have the claimed ratio of peak heights. EX1003, ¶¶185-197.

a. Inaba discloses Element [6.1]

Inaba discloses or suggests this element. EX1003, ¶¶186-187. Specifically, Inaba discloses *the silicon-based material* (composite of SiO_x and carbon material) has *a ratio of a peak height at a wavenumber of $500\text{ cm}^{-1} \pm 10\text{ cm}^{-1}$ (I_{510} , Si peak, peak at 510 cm^{-1}) to a peak height at a wavenumber of $1350\text{ cm}^{-1} \pm 10\text{ cm}^{-1}$ (I_{1343} , carbon peak, peak at 1343 cm^{-1}) in a Raman spectrum (Raman spectrum) is greater than 0 (0.25 or less).*

Inaba obtains a “Raman spectrum” via Raman spectroscopy analysis for the silicon oxide and carbon composite material. EX1007, ¶[0052]. The intensity of the peak at 510 cm^{-1} is the silicon peak (I_{510}), while the intensity of the peak at 1343 cm^{-1} is the carbon peak (I_{1343}). *Id.*, ¶¶[0052]-[0053]. Inaba prefers the ratio of I_{510}/I_{1343} be 0.25 or less. *Id.*, ¶[0052]. Within this range, the portions where the silicon oxide particle surface is exposed are small, and therefore carbon’s effect on improving conductivity is “more remarkably exhibited.” *Id.*, ¶[0054]. A POSITA would have understood Inaba’s ratio I_{510}/I_{1343} is greater than zero, as a ratio of zero means there is no silicon exposed or near the surface of the composite particle or the particle surface is completely covered with a layer of carbon thick enough to block any Raman signal from underlying silicon. EX1003, ¶187. As Inaba’s negative electrode active material contains silicon (and a finite amount of carbon), it would necessarily have an I_{510} greater than zero. *Id.* Therefore, Inaba discloses or suggests this claim.

b. Rationale to combine Manabe and Inaba

A POSITA would have been motivated, with a reasonable expectation of success, to modify Manabe’s negative electrode active layer to exhibit Raman spectroscopy peak height ratios taught by Inaba, resulting in claim 6. EX1003, ¶¶188-197.

i. Analogous art

See Section IX.B.1.b.i; EX1003, ¶189.

ii. Teaching, suggestion, motivation

Inaba teaches, suggests, and motivates a POSITA to configure Manabe's negative electrode active layer to have the claimed ratio of Raman spectroscopy peak heights as taught by Inaba. EX1003, ¶¶190-193.

While Manabe discloses coating the surface of its SiO_x material with carbon (Section VIII.F.1), it does not disclose further details regarding the carbon coating. EX1003, ¶191. Therefore, a POSITA would have been motivated to look to a second reference for more information on coating silicon oxide with carbon.

Inaba teaches greater details of coating silicon oxide with carbon. EX1007, ¶¶[0042]-[0051]. Specifically, Inaba teaches the ratio of intensities, in Raman spectroscopy, of the silicon peak to carbon peak should be 0.25 or less. *Id.*, ¶[0052]. At this ratio, “the effect of improving conductivity due to compositing SiO_x with carbon material is more remarkably exhibited.” *Id.*, ¶[0054]. Inaba further teaches how to obtain the desired intensity ratio (i.e., sufficient carbon coating of the silicon oxide) by adjusting the preparation conditions. *Id.* For example, “treatment temperature, treatment time, concentration of the liquid source of the carbon material in the treatment environment, and the like” can be adjusted to obtain the intensity ratio. *Id.*

Manabe coats the surface of SiO_x with carbon to improve conductivity. EX1005, ¶[0055]. Inaba's intensity ratio ensures the "improv[ed] conductivity due to compositing SiO_x with carbon material is more remarkably exhibited." EX1007, ¶[0054]. Therefore, a POSITA would have implemented Inaba's intensity ratio, in Raman spectroscopy, of silicon peak to carbon peak to improve the conductivity of Manabe's negative electrode mixture layer. EX1003, ¶193.

iii. Use of Known Technique to Improve Similar Devices in the Same Way

A POSITA would have modified Manabe's negative electrode in the manner taught by Inaba in order to improve the conductivity of Manabe's negative electrode. EX1003, ¶¶194-196.

Base device (Manabe's negative electrode): Manabe discloses a negative electrode embodying claim element [6.1] except Manabe does not disclose the peak height ratios, in Raman spectroscopy, of its carbon coated silicon oxide material. *See* Sections VIII.D; VIII.F. Thus, Manabe does not discuss specifics of the carbon coating on the silicon oxide material. EX1003, ¶195.

Comparable device (Inaba's negative electrode): Inaba teaches in a Raman spectrum, the peak at 510cm^{-1} is the silicon peak, while the peak at 1343 cm^{-1} is the carbon peak. EX1007, ¶¶[0052]-[0053]. Inaba further teaches the ratio of the silicon peak to carbon peak indicates how thoroughly the silicon oxide is covered by the

carbon coating. *Id.*, ¶[0054]. The more thoroughly silicon oxide is covered by the carbon coating, the greater the improvement in conductivity of the negative electrode. *Id.* If the ratio of the silicon peak to carbon peak is 0.25 or less, the carbon coating is sufficient to “remarkably exhibit[]” improved conductivity in the negative electrode. *Id.* Thus, a POSITA would have been motivated to improve the negative electrode of Manabe by coating the SiO_x material with carbon sufficiently such that the ratio of the silicon peak to carbon peak, in Raman spectroscopy, is 0.25 or less. EX1003, ¶196.

iv. Reasonable expectation of success

A POSITA would have had a reasonable expectation of success in improving Manabe’s negative electrode by carbon coating the SiO_x material in the same manner as taught by Inaba. Both Inaba and Manabe coat SiO_x with carbon to increase conductivity. EX1005, ¶[0055]; EX1007, ¶¶[0026], [0054]. Moreover, Inaba and Manabe share many other similarities that would have suggested the compatibility of Inaba’s negative electrode Raman spectroscopy peak intensity ratios with Manabe’s negative electrode. *See* Section IX.B.1.b.iv; EX1003, ¶197. As Manabe does not specify or limit the specific implementation of the carbon coating on its SiO_x material, a POSITA would have reasonably expected Inaba’s carbon coated SiO_x material to succeed in Manabe’s negative electrode. EX1003, ¶197.

X. GROUND 3: MANABE AND WANG RENDER OBVIOUS CLAIM 5

A. OVERVIEW OF WANG

Wang discloses a secondary battery comprising a positive electrode, negative electrode, electrolyte, and a separator. EX1009, Abstract, Claim 1, ¶[0006]. By matching the kinetic performance of the positive and negative electrodes, Wang's battery "combines long cycle life, high energy density, and fast charge and discharge capability." *Id.*, ¶¶[0004]-[0005], [0012]. To create this balance, Wang coats the electrodes with active material on one or more surfaces of the current collectors in a manner such that the following equation is satisfied: $0.1 \leq (D50_N \times M_N) / [(D50_P + 4) \times (M_P + 4)] \leq 1.5$. *Id.*, Abstract, Claim 1, ¶¶[0006], [0010]. $D50_N$ and $D50_P$ represent the particle size that 50% of the particles (by volume) are less than in the negative and positive active materials, respectively. *Id.*, ¶[0010]. M_N and M_P represent the capacity per unit area of the negative and positive electrode films, respectively. *Id.*

The larger the active material particle size, the worse the kinetic performance of the electrode. EX1009, ¶¶[0013]-[0014]. And while a larger capacity per unit area of the electrode films results in higher energy density, it worsens kinetic performance. *Id.* Wang discovered the equation above balances these competing factors, resulting in an improved battery. *Id.*, ¶[0015]. If the equation is greater than 1.5, the positive electrode's kinetic performance is far superior to the negative

electrode, causing lithium ions to be reduced and deposited on the surface of the negative electrode. *Id.* This reduces battery performance including capacity and cycle performance. If the equation is less than 0.1, the negative electrode's kinetic performance is far superior to the kinetic performance of the positive electrode, overwhelming the positive electrode with more ions than it can accept, causing polarization, the failure to fully utilize battery capacity, and structural damage to the positive electrode active material, negatively affecting battery cycle life. *Id.*

D50_P is preferably “0.2 μm to 25 μm ,” or more preferably “0.4 μm to 15 μm ” to obtain a positive electrode with better kinetic performance and therefore improved rapid discharge capability and cycle life. EX1009, ¶[0019]. D50_N is preferably “0.4 μm to 30 μm ,” or more preferably “0.5 μm to 16 μm ” to obtain a negative electrode with better kinetic performance and therefore improved rapid discharge capability and energy density. *Id.*, ¶[0022]. M_P is preferably “1 mAh/cm² to 10 mAh/cm²” or more preferably “2 mAh/cm² to 6 mAh/cm²” to obtain better kinetic performance, thus improving rapid discharge capability and energy density. *Id.*, ¶[0020]. M_N is preferably “1 mAh/cm² to 10 mAh/cm²” or more preferably “2 mAh/cm² to 7 mAh/cm²” to improve kinetic performance, leading to improved rapid discharge capability and energy density. *Id.*, ¶[0023].

For both the positive and negative electrodes, the active material film is coated on one or both sides of the current collector, and the film may include a conductive

agent and binder. EX1009, ¶¶[0024]-[0025]. Wang discloses potential positive electrode active materials. *Id.*, ¶[0027]. The negative electrode active material is preferably “one or more of carbon materials, silicon-based materials.” *Id.*, ¶[0028]. The carbon material can be “graphite,” and the silicon-based material can be “silicon, silicon-oxygen compounds, [or] silicon-carbon composites.” *Id.*

Wang discloses experiments testing different active materials at different D50’s and capacities per unit area. EX1009, ¶¶[0032]-[0073]. The experiments compared the following battery performance metrics of the various experimental examples: (1) maximum charge rate; (2) discharge performance; (3) number of cycles; (4) energy density. *Id.*, ¶¶[0058]-[0068], Table 2. The experimental results confirmed when the equation is within the disclosed range, the battery has a long cycle life, high energy density, and rapid charge-discharge capability. *Id.*, Table 2, ¶¶[0070]-[0073].

B. DEPENDENT CLAIM 5

1. [5.1]

Manabe does not expressly disclose the form of the silicon-based material. However, a POSITA would have known there are only two possible states of molecular (or atomic) scale order of these silicon compounds: “crystalline” and “amorphous.” EX1003, ¶203. Therefore, the silicon compounds taught by Manabe are necessarily either crystalline or amorphous because there are no other options.

Id. Therefore, Manabe inherently discloses this claim element. For this same reason (only two possibilities), Manabe renders obvious that its silicon compounds have a crystalline or amorphous state. *Id.*

2. [5.2]

Manabe does not disclose the size distribution of the particles in its NAMs. Wang, however, discloses NAM particle sizes falling in the claimed range and provides motivation to modify Manabe's particles to have the claimed particle size distribution. EX1003, ¶¶204-224.

a. Wang discloses element [5.2]

Wang discloses or suggests this element. EX1003, ¶¶205-211. Specifically, Wang discloses that the *first negative active material layer* (negative electrode active material) *and second negative active material layer* (negative electrode active material) have *particle sizes Dv50 (D50_{neg}) of 8.0 μm to 20 μm (20 μm)*.

Wang teaches the Dv50 of the negative active material is preferably “0.4 μm to 30 μm” and more preferably “0.5 μm to 16 μm.” EX1009, ¶[0022]. These ranges improve the kinetic performance of the negative electrode, which therefore improves the rapid charge capability and cycle life of the battery. *Id.* These ranges overlap the claimed range. Further, Wang's negative active material may be “one or more of carbon materials” and “silicon-based materials.” *Id.*, ¶[0028]. The carbon material

can be “graphite,” and the silicon-based material can be “silicon, a silicon-oxygen compound, [or] silicon-carbon composites.” *Id.* Thus, Wang discloses this element.

Example 16 of Wang discloses a negative electrode with a negative active material comprising graphite and “silicon monoxide” (i.e., silicon oxide) at an 8:2 ratio by mass (80% graphite, 20% silicon monoxide). EX1009, Table 1. The D50 of Example 16’s negative active material is 20 μ m, within the claimed range. *Id.*

To the extent other substances mixed with the negative active material are included in the particle size calculation, Wang’s Example 16 remains within the claimed range. EX1003, ¶¶209-211. Wang’s negative electrode was prepared in the same manner for all examples. EX1009, ¶[0043]. The negative electrode active material was mixed with “the conductive agent Super P, the thickener sodium carboxymethyl cellulose (CMC), and the binder styrene-butadiene rubber (SBR)...at a mass ratio of 94.5:1.5:1.5:2.5.” *Id.*, ¶[0036]. Taking the known particle sizes of these additional constituents, the average particle size of Example 16 is 19.20 μ m—within the claimed range. EX1003, ¶¶209-211

b. Rationale to combine Manabe and Wang

A POSITA would have been motivated, with a reasonable expectation of success, to modify the Dv50 of Manabe’s first and second NAMLs to use the Dv50 of Wang’s Example 16, resulting in claim element [5.2]. EX1003, ¶¶212-224.

i. Analogous art

Manabe, Wang, and the '082 Patent are analogous art as they all are directed to the same field of endeavor: lithium-ion batteries, including details on negative electrodes. *See, e.g.*, EX1001, 1:45-48; EX1005, ¶¶[0011], [0050]-[0061]; EX1009, ¶¶[0001], [0021]-[0022], [0025], [0028].

ii. Teaching, suggestion, motivation

Wang teaches, suggests, and motivates a POSITA to modify the Dv50 of Manabe's first and second NAMLs. EX1003, ¶¶214-216.

Wang teaches the Dv50 of the negative electrode active material is important in optimizing the kinetic performance of the negative electrode. EX1009, ¶¶[0014], [0022]. If the Dv50 is too large, "the poorer the kinetic performance of the negative electrode plate generally is under the same conditions." *Id.*, ¶[0014]. But if the Dv50 is within the range of "0.4 μm to 30 μm " or "more preferably...0.5 μm to 16 μm " the negative electrode has "better kinetic performance, which is more conducive to improving the fast charge capability and cycle life of the secondary battery." *Id.*, ¶[0022]. Example 16 of Wang demonstrated a Dv50 of 20 μm (no smaller than 19.19 μm) produced a battery with excellent charge and discharge performance, plus acceptably good cycle performance. EX1009, Table 2.

Manabe does not disclose particle sizes for its negative electrode mixture layer.¹⁶ Therefore, a POSITA would have been motivated to look to a secondary reference teaching particle sizes for negative electrode active materials. EX1003, ¶216. As excellent charge and discharge performance and increased cycle life are universally desired characteristics for lithium-ion batteries, a POSITA would have been motivated to incorporate the Dv50 of Wang's Example 16 negative electrode active material to obtain those improved characteristics. *Id.*

iii. Use of Known Technique to Improve Similar Devices in the Same Way

A POSITA would have improved Manabe's negative electrode by using the negative active material particle sizes taught by Wang in order to enjoy the benefits of Wang's improved negative electrode. EX1003, ¶¶217-220.

Base device (Manabe's negative electrode): Manabe discloses claim element [5.2] except Manabe does not disclose the particle size of its negative active

¹⁶ Manabe's NAMLs do not require other components besides the negative active materials of graphite and silicon-based material. EX1005, ¶[0051]. Thus, the Dv50 of Manabe's negative active material is the Dv50 of Manabe's NAML. To the extent other components are added, they would not bring the Dv50 below 8.0µm. EX1003, ¶216 n.16.

material. *See* Section VIII.D. Thus, Manabe leaves open the Dv50 of its NAML. EX1003, ¶218.

Comparable device (Wang’s negative electrode): Wang teaches the Dv50 of the negative electrode active materials is important to maintaining good kinetic performance, and therefore improved rapid charge capability and cycle life. EX1009, ¶¶[0014], [0022]; Section X.B.2.b.ii. Wang’s Example 16 negative electrode utilizes graphite and silicon monoxide (same as the SiO_x taught in the ’082 Patent and Manabe when x is 1) as the negative active material, with a Dv50 of 20 μm . EX1009, Table 1; EX1003, ¶219. Example 16 exhibited excellent charge and discharge performance, along with achieving good cycle performance of the battery. EX1009, Table 2; EX1003, ¶219.

Thus, a POSITA would have been motivated to improve Manabe’s negative electrode by using the particle sizes taught by Wang to achieve the known improvements to charging/discharging performance while maintaining acceptable cycle life. EX1003, ¶220.

iv. Reasonable expectation of success

A POSITA would have had a reasonable expectation of success in modifying Manabe’s negative active material particles to have the same Dv50 as taught by Wang. EX1003, ¶¶221-224.

Wang and Manabe both describe negative electrodes for lithium-ion batteries with similar compositions: a current collector coated with negative electrode active material. EX1005, ¶[0051]; EX1009, ¶[0025]. Both disclose negative electrode active material comprising silicon oxide (SiO_x with x in the range taught by the '082 Patent) and graphite with overlapping mass percentages. EX1005, ¶[0053] (5-30% silicon oxide, 70-95% graphite); EX1009, ¶[0028], Table 1 (Example 16: 20% silicon oxide, 80% graphite). Both disclose using binder materials, specifically SBR. EX1005, ¶¶[0044], [0057]; EX1009, ¶[0036]. Both disclose CMC as a thickener. EX1005, ¶[0046]; EX1009, ¶[0036].

Wang and Manabe both disclose positive electrodes comprising lithium transition metal oxides. EX1005, ¶¶[0032]-[0033]; EX1009, ¶[0027], Table 1. Both disclose separators that may be polyethylene. EX1005, ¶[0062]; EX1009, ¶[0040]. And both disclose electrolytes comprising lithium salt (including LiPF_6) in a solvent. EX1005, ¶¶[0063], [0065]; EX1009, ¶[0038].

Accordingly, a POSITA would have recognized Wang and Manabe disclose highly similar batteries with highly similar negative electrodes and negative electrode active materials. Thus, a POSITA would have reasonably expected the Dv50 of Wang Example 16 to be compatible and achievable in Manabe's negative electrode using only routine skill. EX1003, ¶224.

XI. GROUNDS FOR STANDING

Petitioner certifies the '082 Patent is available for IPR and Petitioner is not barred or estopped from requesting IPR of any '082 Patent claim.

XII. MANDATORY NOTICES

Real Party-in-Interest (37 C.F.R. § 42.8(b)(1)): The real parties-in-interest are Petitioner Zhuhai CosMX Battery Co., Ltd; Chongqing CosMX Battery Co., Ltd., Zhuhai CosMX Power Jinwan Subsidiary Co., Ltd., Zhuhai CosMX Power Battery Co., Ltd., Zhuhai CosMX Power Supply Co., Ltd., Zejiang CosMX Battery Co., Ltd., Zejiang CosMX Power Supply Co., Ltd., and Chongqing CosMX Battery Co., Ltd.

Related Matters (37 C.F.R. § 42.8(b)(2)):

Matter	Status
<i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , No. 2:26-cv-00139-JRG (E.D. Tex.). EX1018.	Dismissed <u>WITHOUT</u> prejudice on June 15, 2026. EX1019.
<i>Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.</i> , No. IPR2026-00398 (PTAB) for U.S. Pat. No. 10,916,769	Filed July 21, 2026
<i>Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.</i> , No. IPR2026-00399 (PTAB) for U.S. Pat. No. 12,374,686	Filed July 21, 2026

Lead and Back-up Counsel (37 C.F.R. § 42.8(b)(3)):

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Service Information (37 C.F.R. § 42.8(b)(4)): Please direct all correspondence regarding this Petition to counsel at the above addresses, COSMX-PTAB@leehayes.com and PTAB@sternekessler.com. Petitioner consents to service by email at the addresses above.

XIII. CONCLUSION

Petitioner respectfully requests the Board institute review and cancel challenged claims as unpatentable.

Respectfully submitted,

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/ James D. Stein /

James D. Stein
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Lead Counsel for Petitioner

Date: July 22, 2026

CERTIFICATE OF WORD COUNT (37 C.F.R. § 42.24(d))

This Petition for *Inter Partes* Review complies with the type-volume limitation of 14,000 words, comprising 13,990 words, excluding the parts exempted by 37 C.F.R. § 42.24(a)(1).

This Petition for *Inter Partes* Review complies with the general format requirements of 37 C.F.R. § 42.6(a) and has been prepared using Microsoft® Word in 14-point Times New Roman font.

Respectfully submitted,

LEE & HAYES, P.C.

/ *James D. Stein* /

James D. Stein
Registration No. 63,782
Lead Counsel for Petitioner

Date: July 22, 2026

CERTIFICATE OF SERVICE (37 C.F.R. §§ 42.6(e), 42.105(a))

I certify that the above-captioned **PETITION FOR *INTER PARTES***
REVIEW FOR U.S. PATENT NO. 12,294,082 and associated Exhibits 1001-1019
were served in their entireties upon the Patent Owner on July 22, 2026, via FedEx®
Express at the following address:

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*Patent Owner's Correspondence Address of Record
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Respectfully submitted,

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Lead Counsel for Petitioner

Date: July 22, 2026